USDA
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Breakfast Consumption by School-Aged Children and Adolescents and School Performance, Weight-related Outcomes, and Health

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U.S. School Breakfast Program Best Practices, Including Models of Student Costs and Breakfast Delivery:

A Series of Rapid Reviews

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Background

In a typical fiscal year, almost 91,000 schools served low-cost or free breakfasts through the U.S. School Breakfast Program (SBP) to about 15 million students daily.[a] Involvement in the SBP can play an influential role in school-age children's development of a healthy dietary pattern.[b]

The USDA Nutrition Evidence Systematic Review (NESR) team conducted a rapid review for the USDA Food and Nutrition Service, Office of Policy Support to summarize evidence on the relationship between eating breakfast and school performance, weight-related and health outcomes, and on best practices in the SBP, including models of student costs and breakfast delivery.

Key findings

- Eating breakfast may result in improved learning achievement later in the day, although long-term effects and impact on cognitive development is unclear.
- Increased breakfast frequency in childhood and adolescence may be associated with healthier weight status, though a large proportion of studies find no association.
- Eating breakfast may lead to health benefits throughout the morning, including lower hunger and appetite, higher satiety and glucose levels, and perhaps better mood, but long-term impacts on cardiometabolic and mental health outcomes are unclear.
- SBP universal-free breakfast and breakfast-after-the-bell delivery models, particularly breakfast in the classroom, significantly and substantially increases SBP participation and may increase rates of consuming a nutritionally substantive breakfast.

Methods

A literature search using 4 databases (PubMed, Cochrane CENTRAL, Web of Science, CINAHL Plus) identified articles published from January 2005 through August 2021 that met pre-defined inclusion and exclusion criteria. Eligible interventions examined (a) the intervention or exposure of breakfast consumption, compared to breakfast skipping, in relation to measures of school performance, weight-related outcomes, and health outcomes, or (b) models of SBP delivery, compared to variations in SBP models, in relation to SBP participation, diet quality, breakfast skipping, school preformance and learning achievement, weight-related outcomes, student or teacher satisfaction with the SBP, and health outcomes.

Articles were partially dual screened by 2 NESR analysts based on pre-determined criteria, and a third analyst adjudicated disagreements. Eligible study designs included randomized controlled trials (RCT), non-randomized controlled trials (NRCT), prospective cohort studies (PCS), retrospecitve cohorts, pre-post studies with a control, case control studies, and for acute school preformance and health outcomes only, cross-sectional studies (CS). The SBP best practices review included CS and uncontrolled pre-post studies (UPP) to inform research recommendations. Studies were published in English in peer-reviewed journals, were

[a] United States Department of Agriculture Food and Nutrition Service National Data Bank. Accessed April 25, 2022. https://afnazre3ws08/NDB8/Home/Signin2.aspx

[b] U.S. Department of Agriculture and U.S. Department of Health and Human Services. Dietary Guidelines for Americans, 2020-2025. 9th Edition. December 2020. Available at DietaryGuidelines.gov.

conducted in countries with high or very high levels of human development, and enrolled children and adolescents (5 to 18 years). Studies on SBP best practices were conducted in the U.S. only. Data were extracted and risk of bias was assessed for each article. Evidence was qualitatively synthesized, with attention given to overarching themes, similarities and differences between studies, and factors that may affect results. Summary statements were developed and compared with findings from a previously published comprehensive review[a].

Findings

Breakfast and school performance, 2 RCTs, 1 PCS and 1 CS (nested within a cluster RCT) examined the relationship between eating breakfast and learning achievement, and 12 RCTs, 1 NRCT, 1 cohort study and 3 CS examined breakfast and cognitive development.

- Eating breakfast may result in improved learning achievement later in the day in school-aged children. The evidence comes from four small well-conducted studies with marked heterogeneity. Additional studies are needed to assess acute and longitudinal effects of breakfast consumption in school-aged children.
- The effect of eating breakfast, compared to fasting, on measures of cognitive development in school-aged children is unclear. Despite a reasonable number of studies, the ability to draw conclusions was restricted by inconsistency in study findings, heterogeneity in cognitive tests, and small sample sizes.

Breakfast and weight-related outcomes, 1 RCT and 37 PCS examined the association between breakfast intake during childhood or adolescence and weight-related outcomes.

- Increased frequency of breakfast intake in childhood (5-9y) may be associated with healthier weight-related outcomes, though roughly half of the studies found no statistically significant association. No studies examining overall breakfast intake found an association with greater frequency and less healthy outcomes. These studies enrolled large cohorts of participants with substantial diversity in race/ethnicity and socioeconomic status, as well as long follow-up periods, but they were also limited by high attrition, inconsistent definitions of breakfast, and intake assessments at baseline only.
- Increased frequency of breakfast intake in early adolescence (10-12y) may be associated with healthier weight-related outcomes, particularly lower BMI and healthier weight status, though roughly half of the studies found no statistically significant association. No studies found an association between increased breakfast intake and less healthy BMI or weight status. These studies included long follow-up periods but were limited by high attrition, small sample sizes, greater age group overlap, inconsistent definitions of breakfast, and intake assessment at baseline only.
- Increased frequency of breakfast intake in later adolescence (13y+) showed a more consistent association with healthier weight-related outcomes than in younger populations, particularly for BMI and weight status, with eight of twelve studies supporting that finding. However, these eight studies came from only two cohorts, and the remaining four studies from other cohorts did not find statistically significant associations. No studies found an association between greater breakfast intake and less healthy BMI or weight status. These studies enrolled large cohorts of participants with substantial diversity in race/ethnicity and socioeconomic status, as well as long follow-up periods, but they were limited by high attrition and intake assessments at baseline only.

[a] Murphy, JM. Breakfast and learning: an updated review. *Current Nutrition & Food Science.* 2007; 3(1):3-36. https://doi.org/10.2174/1573401310703010003

Breakfast and health, 19 articles, including 8 RCT, 1 NRCT, and 10 PCS examined the association between breakfast intake during childhood or adolescence and health outcomes*.*

- Eating breakfast, compared to no breakfast, results in lower hunger, lower appetite, and higher satiety, with effects measured as long as 4 hours after breakfast. The evidence, from three randomized controlled trials, is most generalizable to early adolescence (ages 12 to 14 years), as there is no evidence from other age groups. These findings are limited because participants could not be blinded, which could have had an impact on their subjective, self-reported outcomes.
- Eating breakfast may result in favorable mood outcomes throughout the morning. However, some of the available evidence suggests that these subjective, participant-reported outcomes may have been influenced by a lack of participant blinding.
- Eating breakfast results in higher glucose levels than fasting, with effects measured as long as 3 hours after breakfast. The evidence, from two well-conducted randomized controlled trials, was consistent in 9-year-olds with obesity and a sample of predominantly female 16-year-olds with a normal BMI.
- Some studies found that eating breakfast, compared with fasting, results in higher triglycerides, insulin, PYY, resting energy expenditure, and carbohydrate oxidation, and lower glucagon, ghrelin, and lipid oxidation during the morning. However, few studies examined these outcomes, and the evidence is limited in its generalizability.
- Associations between breakfast consumption during childhood and adolescence and long-term cardiometabolic and mental health outcomes are unclear. The evidence was inconclusive because it was from a small number of studies with inconsistent findings and limitations.

SBP best practices, 24 articles from 3 RCT, 8 NRCT, 6 CS, and 3 UPP studies examined SBP best practices, RCT and NRCT informed summary statements.

- U.S. School Breakfast Program universal-free breakfast and breakfast-after-the-bell delivery models, particularly breakfast in the classroom (or a combination of these models) compared to traditional School Breakfast Program delivery, significantly and substantially increases School Breakfast Program participation. Evidence is from large, well designed intervention studies conducted in diverse grades and socioeconomic student groups.
- Universal-free breakfast or breakfast in the classroom may increase rates of consuming a nutritionally substantive breakfast (e.g., consume food from at least two of five food groups and intake of greater than 10% of daily energy requirements). Evidence is from two large, rigorous intervention studies conducted in high-poverty, urban elementary and middle schools.
- The effect of universal-free breakfast in the classroom on weight-related outcomes is unclear due to insufficient evidence. However, one rigorous study conducted in high-poverty urban schools found breakfast in the classroom increased the incidence of obesity but found breakfast in the classroom had no significant effect on combined incidence of overweight and obesity at 2.5 years of intervention. Additional longitudinal research is needed on the impact of free breakfast in the classroom on weight-related outcomes and eating behaviors using research designs with sufficient power to explore the effect of baseline weight, socioeconomic status, and urbanicity.
- Breakfast in the classroom and universal-free School Breakfast Program have little effect on measures of attendance and academic achievement during the first year of implementation in elementary and middle school children. Additional longitudinal research is needed on universal-free breakfast and breakfast-after-

the-bell models and measures of attendance, and chronic absenteeism, particularly among high school students.

- The relationship between the School Breakfast Program student cost and delivery models and breakfast skipping, student/teacher satisfaction, and health is unclear due to lack of evidence.

Recently published studies provide new evidence and confirms previous findings published by Murphy, 2007[a] with more rigorous study designs and data exclusively from studies conducted in school-aged children and adolescents from high and very high development countries. There are several research recommendations that apply to evidence examining breakfast eating and SBP models in schoolchildren.

- Conduct experimental studies that examine a variety of breakfast interventions that more closely resemble students' habitual breakfast consumption.
- Evaluate characteristics of the breakfast meal (e.g., location, timing, type of food, macronutrient composition, specific portion size, and calorie content) and other foods and beverages consumed through the day using well-controlled studies to enhance understanding of relationships identified.
- Explore the impact of BIC on weight-related outcomes using strong, longitudinal study designs that have sufficient power to evaluate the effect of baseline weight, school level, SES, and urbanicity.
- Enroll adequate samples of students with a range of demographic characteristics including more middle school and high school students, and students of varying weight status, and socioeconomic status to improve generalizability of results.
- Use valid measures consistently to build a body of evidence specifically for cognitive and health outcomes.

[a] Murphy, JM. Breakfast and learning: an updated review. Current Nutrition & Food Science. 2007; 3(1):3-36. https://doi.org/10.2174/1573401310703010003.

Rapid reviews

Introduction

The School Breakfast Program (SBP) is a federally assisted meal program that operates in public and non-profit private schools and residential childcare institutions[a]. The USDA Food and Nutrition Service (FNS) administers SBP at the federal level, and institutions that participate in the SBP operate non-profit breakfast programs that serve meals that meet federal nutrition requirements[b] and offer free or reduced-price breakfast to eligible students. Free breakfast is provided to children who participate in certain federal assistance programs, such as the Supplemental Nutrition Assistance Program, and children from families with incomes at or below 130 percent of the federal poverty level, and reduced-price breakfast (costing no more than 30 cents) is provided to children from families with incomes between 130 and 185 percent of the federal poverty level[e].

In a typical fiscal year, almost 91,000 schools served low-cost or free breakfasts through the SBP to about 15 million students daily.[c] In light of recent disruptions due to the COVID-19 pandemic, FNS has issued waivers granting increased flexibilities to ensure students can continue to access healthy breakfasts and lunches.[d]

The FNS Office of Policy Support (OPS) conducts and oversees research to promote effective policies and strong management of the SBP.[e] The rapid reviews reported herein were sponsored by OPS and conducted by USDA's Nutrition Evidence Systematic Review (NESR) team to inform SBP communication and research activities. NESR is a team of systematic review scientists at the USDA Center for Nutrition Policy and Promotion who specialize in conducting evidence-based reviews to inform Federal nutrition policies and programs.

A narrative review from 2007, which summarized evidence about the associations of breakfast consumption or school breakfast with student outcomes, provided a foundation for these rapid reviews.[f] The goal of the rapid reviews was to expand upon the conclusions of that existing review, or draw new conclusions, after identifying, evaluating, and synthesizing new peer-reviewed research with evidence about:

- The relationship between eating breakfast and school performance,
- The relationship between eating breakfast and weight-related outcomes,
- The relationship between eating breakfast and health, and
- Best practices in SBP, including models of student costs and breakfast delivery.

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[a] United States Department of Agriculture Food and Nutrition Service. School Breakfast Program. Accessed March 21, 2022. https://www.fns.usda.gov/sbp/school-breakfast-program

[b] United States Department of Agriculture Food and Nutrition Service. Nutrition Standards for School Meals. March 11, 2022. Accessed March 21, 2022. https://www.fns.usda.gov/cn/nutrition-standards-school-meals

[c] United States Department of Agriculture Food and Nutrition Service National Data Bank. Accessed April 25, 2022. https://afnazre3ws08/NDB8/Home/Signin2.aspx

[d] United States Department of Agriculture Food and Nutrition Service. Child Nutrition COVID-19 Waivers. Accessed April 25, 2022. https://www.fns.usda.gov/fns-disaster-assistance/fns-responds-covid-19/child-nutrition-covid-19-waivers

[e] United States Department of Agriculture Food and Nutrition Service. Research & Analysis. Accessed March 21, 2022. https://www.fns.usda.gov/research-analysis

[f] Murphy, JM. Breakfast and learning: an updated review. *Current Nutrition & Food Science.* 2007; 3(1):3-36. https://doi.org/10.2174/1573401310703010003.[g] Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, Cates CJ, Cheng H-Y, Corbett MS, Eldridge SM, Hernán MA, Hopewell S, Hróbjartsson A, Junqueira DR, Jüni P, Kirkham JJ, Lasserson T, Li T, McAleenan A, Reeves BC, Shepperd S, Shrier I, Stewart LA, Tilling K, White IR, Whiting PF, Higgins JPT. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ* 2019; 366: l4898. https://doi.org/10.1136/bmj.l4898.

Methods

A NESR rapid review is an evidence-synthesis project that answers a nutrition question of public health importance using streamlined systematic review methods. Methods used to search for, evaluate, synthesize, or assess the evidence may be tailored to conserve resources and produce a timelier product when full systematic review methods are not needed or feasible.

NESR team members coordinated development of the rapid review protocol with study sponsors. The protocol was developed *a priori* and defined the scope of the research questions, including the analytic framework and inclusion and exclusion criteria, and defined the rapid review methods appropriate to meet project objectives. Herein, we report the final methods used to conduct the rapid reviews.

Rapid review questions:

- Key Question 1a: What is the relationship between eating breakfast and school performance?
- Key Question 1b: What is the relationship between eating breakfast and weight-related outcomes?
- Key Question 1c: What is the relationship between eating breakfast and health?
- Key Question 2: What best practices exist in SBP, including models of student costs and breakfast delivery?

Develop analytic frameworks

Analytic frameworks visually represent the overall scope of the rapid review questions and depict the contributing elements that were examined and evaluated.

Figure 1 is the analytic framework for the rapid review conducted to answer Key Question 1: What are the relationships between eating breakfast and school performance, weight-related outcomes, and health? The intervention or exposure of interest was breakfast consumption in school-aged children and adolescents from kindergarten through 12th grade or ages 5 to 18 years. The comparator was breakfast skipping. Key Question 1a examined school performance outcomes in school-aged children and adolescents, including measures of school participation (e.g., enrollment, attendance, tardiness, absenteeism, visits to the school nurse's office, disciplinary incidents, concentration, focus, completion of tasks or assignments, dropout rates, and grade repetition), and measures of learning achievement and cognitive development (e.g., standardized test scores, grades, verbal fluency, memory, reasoning, and intelligence). Key question 1b examined weight-related outcomes in school-aged children through adults, including anthropometric measures (e.g., weight, height, weight change, size and growth indices, body composition indices, percent body fat, and body mass index), and the incidence and prevalence of healthy weight, overweight, and obesity. Key question 1c examined three categories of health outcomes. The first category was physiological effects of breakfast consumption in school-aged children and adolescents, including perceived hunger and satiety, gastrointestinal hormones, blood glucose, blood lipids, resting energy expenditure, and macronutrient oxidation in a fasted versus fed state.The second category was cardiometabolic health outcomes in school-aged children through adults, including metabolic syndrome, type 2 diabetes, blood pressure, blood lipids, glucose, and insulin, and fitness. The third category was mental health outcomes in school-aged children through adults, including mood, happiness, stress, anxiety, and depression. The key confounders for Key Question 1 were age, sex, socioeconomic status, race/ethnicity, and physical activity. The additional key confounder of baseline and parent BMI was included for Key Question 1b: body weight, and the additional key confounder of body weight was included for Key Question 1c: health.

Figure 1. Analytic framework for Key Question 1: What are the relationships between eating breakfast and school performance, weight-related outcomes, and health?

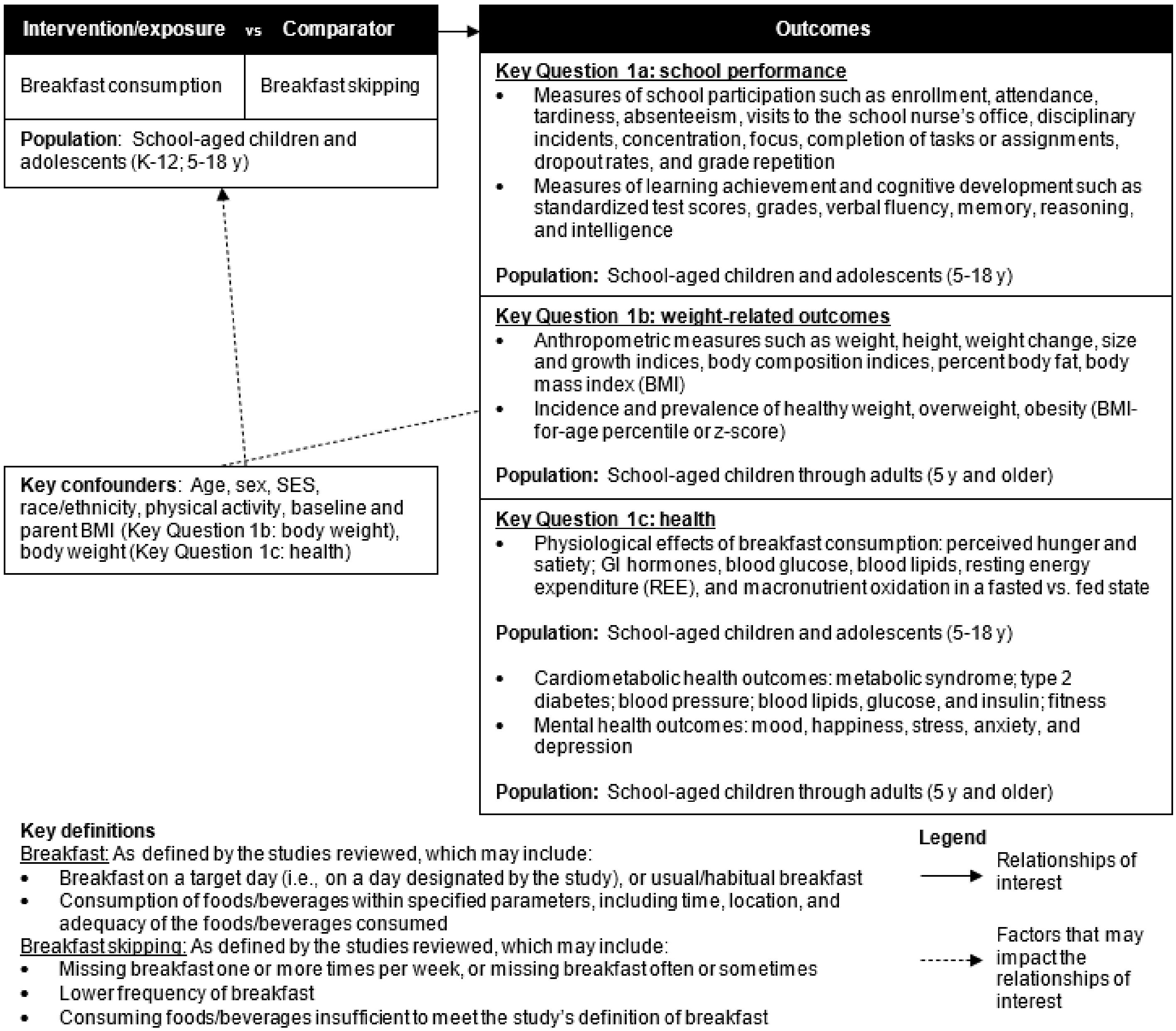
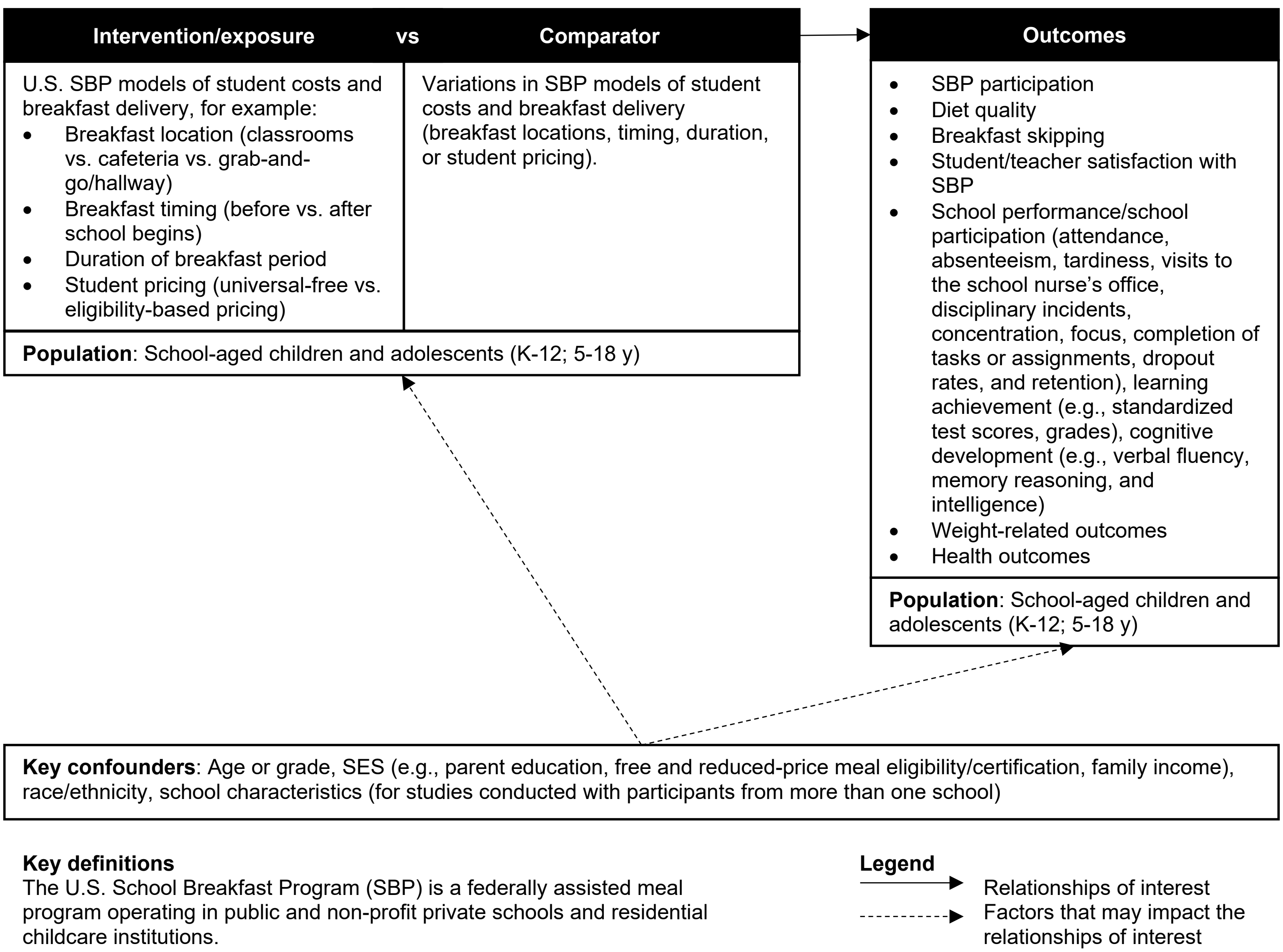


Figure 2 is the analytic framework for the rapid review conducted to answer Key Question 2: What best practices exist in the U.S. School Breakfast Program, including models of student costs and breakfast delivery? The interventions or exposures of interest were SBP models of student costs and breakfast delivery in school-aged children and adolescents from kindergarten through 12th grade. SBP models of student costs and delivery models include breakfast location (such as classrooms vs. cafeteria vs. grab-and-go/hallway), breakfast timing (such as before vs. after school begins), duration of breakfast period, and student pricing (such as universal-free vs. eligibility-based pricing). The comparator was variations in SBP cost and delivery models. Outcomes included SBP participation, breakfast skipping, diet quality, teacher and student SBP satisfaction, school performance/participation (attendance, absenteeism, tardiness, visits to the school nurse's office, disciplinary incidents, concentration, focus, completion of tasks or assignments, dropout rates, and retention), learning achievement (e.g., standardized test scores, grades), cognitive development (e.g., verbal fluency, memory reasoning, and intelligence), weight-related outcomes, and health outcomes. The key confounders were age or grade, SES (e.g., parent education, free and reduced-price meal eligibility/certification, family income), race/ethnicity, school characteristics (for studies conducted with participants from more than one school).

Figure 2. Analytic framework for Key Question 2: What best practices exist in the U.S. School Breakfast Program, including models of student costs and breakfast delivery?



Develop inclusion and exclusion criteria

The inclusion and exclusion criteria for the rapid reviews are presented in **Table 1** and **Table 2**. These criteria are a set of characteristics used to determine which articles identified in the literature search will be included in or excluded from the rapid review.

Table 1. Inclusion and exclusion criteria for Key Question 1: What are the relationships between eating breakfast and school performance, weight-related outcomes, and health?

Category	Inclusion Criteria	Exclusion Criteria
Publication status	Studies published in peer-reviewed journals (including accepted pre-publication manuscripts)	Grey literature, including unpublished data, manuscripts, reports, abstracts, conference proceedings
Date range	January 2005-August 2021	Before 2005
Publication language	English	Languages other than English
Study design	Randomized controlled trials (including crossover trials) Non-randomized controlled trials (including quasi-experimental studies) Prospective and retrospective cohort studies Pre-post studies with a control Case-control studies Cross-sectional studies (acute outcomes[a] only)	Intervention studies without a control or comparison group Cross-sectional studies (non-acute outcomes) Treatment studies enrolling 100% underweight/overweight/obese[b] Multi-component interventions that do not statistically parse out the unique impact of breakfast Systematic reviews, reports from government, clearinghouses, and other authoritative organizations
Study setting	Studies conducted in countries listed as very high or high on the 2016 Human Development Index[c]	Studies conducted in countries listed as medium or low on the 2016 Human Development Index
Age of study participants	Intervention/exposure age: school-aged children and adolescents in grades K through 12, ages 5-18 years Outcome age: school-aged children and adolescents in grades K through 12, ages 5-18 years for all outcomes; adults ages 19 years and older for weight-related and health outcomes	Infants/children younger 5 years of age Adults ages 19 years and older for school performance outcomes
Intervention/ exposure	Breakfast consumption; definitions will vary across studies and may include: • Breakfast on a target day (i.e., on a day designated by the study), or usual/habitual breakfast • Consumption of foods/beverages within specified parameters, including time, location, and adequacy of the foods/beverages consumed, for example: ○ Consumption of any food or beverage anywhere and at any time in the morning	

	○ Breakfast intake of food energy greater than 10 percent of the Recommended Dietary Allowance ○ Consumption of foods from at least two of five main food groups and intake of food energy greater than 10 percent of the Recommended Dietary Allowance	
Comparator	Breakfast skipping; definitions will vary across studies and may include: • Missing breakfast one or more times per week or missing breakfast often or sometimes • Lower frequency of breakfast • Consuming foods/beverages insufficient to meet the study's definition of breakfast	Skipping breakfast because of religious fasting or time-shifted eating (e.g., intermittent fasting)
Outcome	Key Question 1a: school performance • Measures of school participation such as enrollment, attendance, tardiness, absenteeism, visits to the school nurse's office, disciplinary incidents, concentration, focus, completion of tasks or assignments, dropout rates, and grade repetition • Measures of learning achievement and cognitive development such as standardized test scores, grades, verbal fluency, memory reasoning, and intelligence Key Question 1b: weight-related outcomes • Anthropometric measures such as weight, height, weight change, size and growth indices, body composition indices, percent body fat, body mass index • Incidence and prevalence of healthy weight, overweight, obesity (BMI-for-age percentile or z-score) Key Question 1c: health • Physiological effects of breakfast consumption, including perceived hunger, satiety, and thirst; GI hormones, blood glucose, blood lipids, resting energy expenditure, and macronutrient oxidation in a fasted vs. fed state • Longitudinal cardiometabolic health outcomes, including metabolic syndrome; type 2 diabetes; blood pressure; blood lipids, glucose, and insulin; fitness • Longitudinal mental health outcomes including mood, happiness, stress, anxiety, and depression	

[a] Short-term effects of breakfast, which must be assessed using a cross-sectional design, relevant for school performance and health outcomes only

[b] Relevant for weight and health outcomes only

[c] United Nations Development Programme. Human Development Indices and Indicators, 2016 Statistical Update. New York, 2016.

Table 2. Inclusion and exclusion criteria for Key Question 2: What best practices exist in the U.S. School Breakfast Program, including models of student costs and breakfast delivery?

Category	Inclusion Criteria	Exclusion Criteria
Publication status	Studies published in peer-reviewed journals (including accepted pre-publication manuscripts)	Grey literature, including unpublished data, manuscripts, reports, abstracts, conference proceedings

Date range	January 2005-August 2021	Before 2005
Publication language	English	Languages other than English
Study design	Randomized controlled trials Non-randomized controlled trials (including quasi-experimental studies) Prospective and retrospective cohort studies Cross-sectional studies Uncontrolled pre-post-studies	Systematic reviews, reports from government, clearinghouses, and other authoritative organizations
Study setting	U.S. only	
Age of study participants	School-aged children and adolescents in grades K through 12, ages 5-18 years	Infants/children younger than 5 years of age Adults ages 19 years and older
Intervention/ exposure	U.S. SBP models of student costs and breakfast delivery, for example: • Breakfast location (classrooms vs. cafeteria vs. grab-and-go/hallway) • Breakfast timing (before vs. after school begins) • Duration of breakfast period • Student costs (universal-free vs. eligibility-based pricing)	
Comparator	Variations in SBP models of student costs and breakfast delivery (breakfast locations, timing, duration, or student pricing)	
Outcome	• SBP participation • Diet quality • Breakfast skipping • Student/teacher satisfaction with SBP • School performance/school participation (attendance, absenteeism, tardiness, visits to the school nurse's office, disciplinary incidents, concentration, focus, completion of tasks or assignments, dropout rates, and retention), learning achievement (e.g., standardized test scores, grades), cognitive development (e.g., verbal fluency, memory reasoning, and intelligence) • Weight-related outcomes • Health outcomes	

Search for and select studies

The NESR librarians conducted literature searches in PubMed, Cochrane CENTRAL, Web of Science, and CINAHL Plus with Full Text to identify studies that examined (1) breakfast consumption in school-aged children and adolescents and (2) SBP best practices. The full search strategies are described in **Table 3**, **Table 4**, **Table 5**, and **Table 6**. An initial search was in June 2018 and an updated search was run in August 2021.

NESR analysts screened the electronic database search results, after the removal of duplicate records, using systematic review software (DistillerSR, Evidence Partners Inc., Ottawa, Ontario, Canada). To streamline NESR's systematic review methods for this rapid review, the search results were not fully dual-screened.

Instead, for the initial search results, a second analyst dual screened 10-20% percent of the full-text articles. For the updated search results, all articles were dual screened. A third analyst adjudicated disagreements.

A second element of the streamlined approach was that a manual search of the reference lists of included articles was not conducted.

Table 3. Literature search conducted June 25, 2018 and August 31, 2021 in the database PubMed (provider: U.S. National Library of Medicine) with a search date range of January 2005 through August 2021

Concept	Set #	Syntax
Breakfast	1	"Breakfast"[Mesh] OR breakfast* OR morning meal*
	2	(morning AND (meal* OR foods OR "Food and Beverages"[Mesh] OR "Food Services"[Mesh] OR snack* OR beverage* OR appetite OR hunger OR "diet"[tiab] OR "diet"[Mesh] OR dietary[tiab] OR "Diet, Food, and Nutrition"[Mesh] OR "Feeding Behavior"[Mesh] OR "nutrition"[tiab] OR eat* OR "eating habits" OR carbohydrate* OR cereal* OR "Edible Grain"[Mesh] OR fruit* OR "milk"[Mesh] OR "milk"[tiab] OR egg* OR meat* OR "protein"[tiab] OR "Proteins"[Majr] OR ready-to-eat OR "sugar"[tiab] OR "Sugars"[Mesh] OR "caloric intake" OR "Energy Intake"[Mesh])))
	3	#1 OR #2
Child (ages 5-18 y)	4	(child*[tiab] OR "child"[MeSH] OR adolescen* OR "Adolescent"[Mesh] OR youth* OR "young people" OR schoolchild* OR teen* OR kids OR student* OR "high school" OR "middle school" OR "elementary school" OR k-12 OR "Child Nutrition Disorders"[Mesh] OR "Adolescent Nutritional Physiological Phenomena"[MAJR] OR "Child Nutritional Physiological Phenomena"[MAJR])
Limits	5	NOT (Animal* [mh] NOT (Animal* [mh] AND Human* [mh])) NOT (("Review"[Publication Type] OR "systematic review"[tiab] OR "meta-analysis"[Publication Type] OR "meta synthesis"[tiab] OR "rapid review"[tiab] OR "editorial"[Publication Type] OR "comment"[Publication Type] OR "news"[Publication Type] OR "letter"[Publication Type] OR "Congresses"[Publication Type] OR "Clinical Conference"[Publication Type]) AND ("2005/01/01"[PDAT] : "2018/12/31"[PDAT] AND English[LANG]))
Breakfast AND Child AND Limits	6	#3 AND #4 AND #5

Table 4. Literature search conducted June 25, 2018 and August 31, 2021 in the database Cochrane Central Register of Controlled Trials (Cochrane CENTRAL, provider: John Wiley & Sons) with a search date range of January 2005 through August 2021.

Concept	Set #	Syntax
Breakfast	1	Breakfast* OR morning meal*:ti,ab,kw (Word variations have been searched)
	2	MeSH descriptor: [Breakfast] explode all trees
	3	morning NEAR (meal* OR foods OR "Food and Beverages" OR "Food Services" OR snack* OR beverage* OR appetite OR hunger OR diet OR dietary OR "Diet, Food, and Nutrition" OR eat* OR "eating habits" OR "Feeding Behavior" OR nutrition OR carbohydrate* OR cereal OR "edible grain" OR fruit* OR milk OR egg*

		OR meat* OR protein* OR ready-to-eat OR sugar OR "caloric intake" OR "energy intake"):ti,ab,kw (Word variations have been searched)
	4	#1 OR #2 OR #3
Child (ages 5-18 y)	5	[mh Child] OR [mh Adolescent] OR [mh ^"Adolescent Nutritional Physiological Phenomena"] OR [mh ^"Child Nutritional Physiological Phenomena"]
	6	child* OR adolescen* OR youth* OR "young people" OR schoolchild* OR teen* OR kids OR student* OR high school* OR middle school* OR elementary school* OR k-12
	7	((child* or adolescen* or youth*or "young people" or teen* or kids* or student* or pre-school or preschool) NEAR (school* or school-based or education or k-12))
	8	#5 OR #6 OR #7
Breakfast AND Child	9	#4 and #8 (Word variations have been searched)
Limits	10	Dates: Publication Year from 2005 to June 2018 Content Type: Trials

Table 5. Literature search conducted June 25, 2018 and August 31, 2021 in the database Web of Science Core (provider: Clarivate) with a search date range of January 2005 through August 2021.

Concept	**Set #**	**Syntax**
Breakfast	1	ts= (breakfast* OR morning meal*)
	2	ts= (morning NEAR/4 (meal* OR foods OR "Food and Beverages" OR "Food Services" OR snack* OR beverage* OR appetite OR hunger OR diet OR dietary OR "Diet, Food, and Nutrition" OR eat* OR "eating habits" OR "Feeding Behavior" OR nutrition OR carbohydrate* OR cereal OR "edible grain" OR fruit* OR milk OR egg* OR meat* OR protein* OR ready-to-eat OR sugar OR "caloric intake" OR "energy intake"))
	3	#1 OR #2
Child (ages 5-18 y)	4	ts=(child* OR adolescen* OR youth* OR "young people" OR schoolchild* OR teen* OR kids OR student* OR "high school" OR "middle school" OR "elementary school" OR k-12 OR "Child Nutrition Disorders" OR "Adolescent Nutritional Physiological Phenomena" OR "Child Nutritional Physiological Phenomena")
	5	ts=((school* or k-12 or education) NEAR/3 (child* or adolescen* or kids* or student* or pre-school or preschool or "young people" or youth)
	6	#4 OR #5
Breakfast AND Child	7	#3 AND #6
Limits	8	Dates: Timespan 2005-2018 Document Types: (Article OR Early Access) Language: English Refined by: [excluding] Document Types: (Proceedings paper or book chapter)

Table 6. Literature search conducted June 25, 2018 and August 31, 2021 in the database Cumulative Index to Nursing and Allied Health Literature Plus (CINAHL Plus, provider: EBSCO*host*) with a search date range of January 2005 through August 2021.

Concept	Set #	Syntax
Breakfast	1	(MM "Breakfast") OR breakfast* OR morning meal*
	2	(morning) N4 (meal* OR foods OR (MH "Food and Beverages+") OR (MH "Food Services+") OR snack* OR beverage* OR appetite OR hunger OR diet OR dietary OR (MH "Nutrition+") OR eat* OR "eating habits" OR (MH "Eating Behavior+") OR nutrition OR carbohydrate* OR cereal OR "edible grain" OR fruit* OR milk OR egg* OR meat* OR protein* OR ready-to-eat OR sugar OR "caloric intake" OR "energy intake")
	3	#1 OR #2
Child (ages 5-18 y)	4	(child* OR adolescen* OR youth* OR "young people" OR schoolchild* OR teen* OR kids OR student* OR "high school" OR "middle school" OR "elementary school" OR k-12)
	5	(MM "Adolescent Nutrition") OR (MM "Child Nutrition") OR (MM "Child Nutrition Disorders")
	6	#4 OR #5
Breakfast AND Child	7	#3 AND 6
Limits	8	Dates: 2005-2018 Document Type: Peer Reviewed English: Language Exclude MEDLINE records; Publication Type: meta-analysis, systematic review

Extract data and assess the risk of bias

A single NESR analyst independently extracted data and completed the appropriate risk of bias tool for each included study. The data extraction items were chosen *a priori* and were related to the study characteristics, participant characteristics, intervention(s), comparator(s), outcome(s), and results. A second NESR analyst reviewed the extracted data to verify accuracy and completeness.

The revised Cochrane Risk-of-Bias 2.0 (RoB 2.0) tool was used to assess risk of bias for randomized controlled trials (RCTs). The most recent versions of RoB 2.0 at the time of review were used according to study design: the 2019 version of RoB 2.0 was used for individually randomized trials,[a] whereas the 2016 version of RoB 2.0 was used for cluster-RCTs[a] and the ROBINS-I tool was used for non-randomized studies.[b]

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[a] Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, Cates CJ, Cheng H-Y, Corbett MS, Eldridge SM, Hernán MA, Hopewell S, Hróbjartsson A, Junqueira DR, Jüni P, Kirkham JJ, Lasserson T, Li T, McAleenan A, Reeves BC, Shepperd S, Shrier I, Stewart LA, Tilling K, White IR, Whiting PF, Higgins JPT. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ* 2019; 366: l4898. https://doi.org/10.1136/bmj.l4898.

[a] Higgins JPT, Sterne JAC, Savović J, Page MJ, Hróbjartsson A, Boutron I, Reeves B, Eldridge S. A revised tool for assessing risk of bias in randomized trials In: Chandler J, McKenzie J, Boutron I, Welch V (editors). Cochrane Methods. Cochrane Database of Systematic Reviews 2016, Issue 10 (Suppl 1). https://doi.org/10.1002/14651858.CD201601.

[b] Sterne JAC, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, Henry D, Altman DG, Ansari MT, Boutron I, Carpenter JR, Chan AW, Churchill R, Deeks JJ, Hróbjartsson A, Kirkham J, Jüni P, Loke YK, Pigott TD, Ramsay CR, Regidor D, Rothstein HR, Sandhu L, Santaguida PL, Schünemann HJ, Shea B, Shrier I, Tugwell P, Turner L, Valentine JC, Waddington H, Waters E, Wells GA, Whiting PF, Higgins JPT. ROBINS-I: a tool for assessing risk of bias in non-randomized studies of interventions. BMJ 2016; 355; i4919. https://doi.org/10.1136/bmj.i4919.

The NESR Risk of Bias for Nutrition Observational Studies tool (RoB-NObs) was used to assess risk of bias for observational studies.[a]

Synthesize the evidence

NESR analysts qualitatively compared, contrasted, combined, and evaluated the body of evidence available to answer the rapid review questions. The qualitative synthesis of evidence, which is accompanied by summary data tables and a description of the body of evidence, identifies and explains similarities and differences between studies and determines whether certain factors impact the relationships being examined.

Develop summary statements

After the body of evidence was described and synthesized, the NESR analyst considered the strengths and limitations of the body of evidence, and then developed summary statements answering the rapid review questions. The summary statements reflected general agreement or disagreement among the studies, and highlighted the populations, interventions or exposures, comparators, and outcomes represented in the literature. Summary statements also indicate where evidence was insufficient or not available.

Recommend future research

Research gaps and methodological limitations identified throughout the rapid review process were used to develop research recommendations that describe the research and methodological advances needed to strengthen the body of evidence. Across the reviews, findings and research recommendations were compared with findings and research recommendations described in an exiting narrative review[b] to assess progress over the past decade.

Peer-review

Three government content experts reviewed the initial report, prior to the update. One Federal government content expert reviewed the final report for clarity.

Protocol amendments

Amendments made to the rapid review protocol are documented in **Table 7**.

Table 7. Protocol amendments

Date	Protocol change	Description
September 2021	Additional inclusion criterion for publication status: Include accepted pre-publication manuscripts.	This protocol change was made during screening to include relevant peer-reviewed research that would be published.
September 2021	Date range modified (from 2005 to June 2018) to Jan 2005 through August 2021	This protocol change was made to update the review before posting to the NESR website

[a] Risk of Bias for Nutrition Observational Studies tool (RoBNObs) (Dietary Guidelines Advisory Committee. 2020. Scientific Report of the 2020 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Agriculture and the Secretary of Health and Human Services. U.S. Department of Agriculture, Agricultural Research Service, Washington, DC.

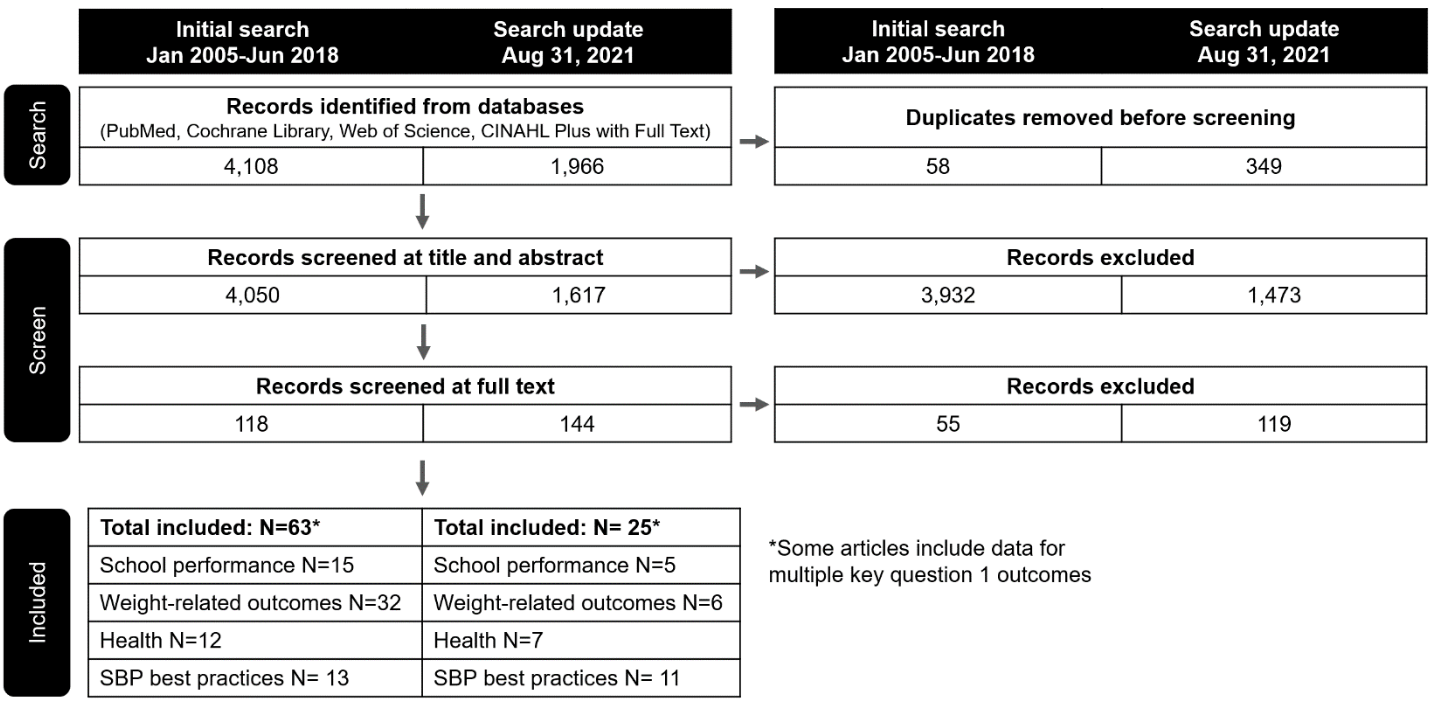
[b] Murphy, JM. Breakfast and learning: an updated review. *Current Nutrition & Food Science.* 2007; 3(1):3-36. https://doi.org/10.2174/1573401310703010003.

Results

Literature search and screening results

The combined literature search yielded 5,667 search results after the removal of duplicates (see **Figure 3**). Screening resulted in the exclusion of 5,405 titles and abstracts, and 174 full-text articles. Reasons for full-text exclusion are in **Appendix 2**. The body of evidence included 88 articles. Some articles included data for multiple key question 1 reviews.

Figure 3. Literature search and screen flowchart



Key Question 1a: What is the relationship between eating breakfast and school performance?

To facilitate meaningful synthesis this body of evidence is presented by outcome: 1) learning achievement and 2) cognitive development.

Description of the evidence – Learning achievement

Study characteristics

The evidence in this rapid review includes 2 randomized controlled trials (RCTs),[1,2] one prospective cohort study,[3] and one cross-sectional study[4] (nested within a cluster RCT) that examined the relationship between eating breakfast and learning achievement. The search timeframe spanned 01/2005 to 08/2021.

The search included articles from very high and high Human Development Index[a] (HDI) countries. Two studies in this body of evidence were conducted in U.S.,[1,4] and one each in U.K.[3] and Singapore.[2] Both U.S. based studies were funded by the government.[1,4] While the U.K. study was co-funded by the government, and research councils and medical charities,[3] the Singapore-based trial was funded by the university.[2]

Sample characteristics

- Sample size: The RCTs in this body of evidence had relatively small sample size (n=40,[2] 81[1]) when compared to the cohort[3] (n=1,216) and cross-sectional[4] (n=162) studies.
- Age range: Two studies enrolled children with a mean age <10 years.[1,4] Littlecott et al.[3] enrolled participants in the age range of 9 to 11 years, while Kawabata et al.[2] primarily enrolled adolescents (14-19 years).
- Race/ethnicity: Except Ptomey et al.[4] who noted that the majority of their participants were non-Hispanic whites, none of the other studies reported participant's race/ethnicity.[1-3]
- Socio-economic status (SES): Pivik et al.[1] reported SES using four-factor index of social positions but did not explain the interpretation of this index. Littlecott et al. noted that ~22% of their participants were from low-income families that were eligible to receive free school meals.[3] Ptomey et al.[4] noted the percentage of participants with household income ≤$50,000 did not differ significantly between breakfast consumers (~37%) and non-consumers (~59%). Kawabata et al.[2] did not report data on SES.
- Health characteristics: Pivik et al.[1] reported mean BMI percentiles of 66.5 and 67.2 among children randomized to fasting and feeding groups, respectively. Ptomey et al.[4] noted that there was no significant difference in the BMI between breakfast consumers and non-consumers. While Kawabata et al. did not report participant's BMI, they noted that none of their participants had clinically diagnosed learning or attention disorders.[2]

Interventions/exposures

- Both RCTs assessed acute effects of breakfast and provided a cereal-based breakfast (e.g., ready-to-eat cereal, sandwich) to the intervention group and included a 'no breakfast' comparator group.[1,2]
- Littlecott et al.[3] used a validated questionnaire to collect data on exposure to breakfast 16-18 months and 4-6 months prior to outcome assessment. The exposure group were those who consumed breakfast on

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[a] United Nations Development Programme. Human Development Indices and Indicators, 2016 Statistical Update. New York, 2016. Available at: http://hdr.undp.org/sites/default/files/2016_human_development_report.pdf

both days of assessment, whereas the comparator group included subjects that consumed breakfast <2 days. Ptomey et al.[4] asked participants to recall their breakfast consumption on the morning of the outcome assessment using USDA multiple pass method.

Outcomes and results

Studies assessed learning achievement, measured based on tests (e.g. WIAT-III, WRAT arithmetic) administered later in the day. All studies assessed math performance,[1-4] and a few others considered additional aspects of learning achievement. For example, Kawabata et al. assessed oral word fluency,[2] and Ptomey et al. assessed spelling, reading fluency and comprehension.[4] Littlecott et al.[3] assessed the association between breakfast consumption to scores on Key Stage 2 Statutory Assessment Tests, a mandatory test for all students in England and Wales for English, Math and Science. The results from each study are presented in **Table 8** and discussed below.

Randomized controlled trials

Kawabata et al.[2] showed that adolescents who consumed breakfast had greater improvements in their math computation time, but not math test scores, when compared to their fasted counterparts. Both groups received exercise as an intervention, in addition to breakfast or no breakfast (i.e., fasting). Pivik et al.[1] showed no significant difference in arithmetic scores between breakfast and fasting groups. However, a significant within-group difference in math performance was found in the breakfast group, with a significantly higher number of correct responses observed on a test administered after breakfast compared to before breakfast. This increase was not observed in the fasting group. In contrast, the fasting group showed a significant decrease in response time with prolonged fasting ($p<0.05$).

Observational studies

Littlecott et al.[3] evaluated the association between breakfast intake and standardized scores. In this cohort study, habitual breakfast intake 16-18 months (baseline) and 4-6 months (follow-up) prior was associated with statutory assessment tests. This study included participants from lower SES (22%) and the analysis adjusted for appropriate confounders. The association with learning achievement was statistically significant regardless of whether habitual breakfast intake was assessed at baseline or follow-up; however, the associations were slightly stronger between follow-up (4-6 months) breakfast intake and learning achievement.

In a cross-sectional study, Ptomey et al.[4] showed a significant association between breakfast intake and math scores, spelling standard scores, and reading comprehension and fluency standard scores later that day, compared to no breakfast intake. Although the study presented cross-sectional analysis, this study was part of a cluster RCT designed to assess the differences in academic achievement between students in schools that were randomized to receive physically active lessons (i.e., two 10-min physically active academic lessons five days/week over the three-year intervention) and those in control schools that received traditional classroom instructions (Donnelly et al. 2013)[a]. The study used robust exposure assessment, using the USDA multiple pass method. To eliminate bias due to systematic differences, breakfast and non-breakfast groups were matched on age, sex, race, education level of both parents, household income, BMI, and cardiovascular fitness. The study included subjects from lower SES and was conducted in a school-based setting, thereby making findings more generalizable.

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[a] Donnelly JE, Greene JL, Gibson CA, et al. Physical activity and academic achievement across the curriculum (A + PAAC): rationale and design of a 3-year, cluster-randomized trial. *BMC Public Health.* 2013;13:307. https://doi.org/10.1186/1471-2458-13-307.

Description of the evidence – Cognitive development

Study characteristics

The evidence in this rapid review includes 12 RCTs,[2,5-15] one NRCT,[16] one prospective cohort studies,[17] and three cross-sectional studies [18-20] that examined the relationship between eating breakfast and cognitive development. The search timeframe spanned 01/2005 to 08/2021.

The search included articles from very high and high Human Development Index[a] (HDI) countries. Three of the 17 studies were conducted in the U.S.,[9,10,12] one each in Chile,[20] China,[17] and Singapore.[2] The remaining studies were conducted in Europe (8 studies in UK,[5-8,14,16,18,19] two in Germany[13,15] and one in Italy.[11]

Sample characteristics

- Sample size: The RCTs included in this rapid review had a sample size that ranged from 10[11] to 845,[15] with a median sample size of ~60. The cross-sectional studies had wide variations in sample sizes with one study[19] enrolling only 20 participants and the other studies enrolling 1,181[20] and 1,386[18] participants, each. The longitudinal cohort had 511[17] participants, while the non-RCT[16] included 213 participants.
- Age range: Studies enrolled children and adolescents in the age range of 4 to 20 years, with five studies including participants with a mean age <10 years[9-11,16,19] and eight studies including participants with mean age ≥10 years.[2,5-8,13,14,20] Mahoney et al. enrolled two groups of participants (6 to 8 years and 9 to 11 years) and conducted a separate analysis for each of the age group.[12] Wesnes et al.[18] enrolled participants in the age range of 6 to 16 years with mean ages between 10 to 11 years. Liu et al.[17] assessed breakfast intake at 6 years and assessed cognitive outcomes at 12 years. Zipp et al.[15] noted that the participants were 8 to 18 years of age.
- Race/ethnicity: Among four studies that reported race/ethnicity, Adolphus et al.[14] noted that the majority of their participants were non-Hispanic whites; Kral et al.[10] noted that 76.2% of the subjects were African Americans; and Iovino et al.[9] reported that 31.3% and 37.5% of the study participants were African American and Hispanic, respectively. The remaining studies did not report race/ethnicity.[2,5-8,11-13,15-20]
- Socio-economic status (SES):
    - Among the intervention studies that reported SES, Mahoney et al.[12] and Smith[16] noted that their participants belonged to the middle-class, while Defeyter and Russo[7] reported that all of their participants were from the lower middle-class. In a trial conducted in the U.S.,[9] about 50% of the participants had a household income <$50,000 and more than half of their participants (54.7%) were eligible for free lunch at school. More than 2/3[rd] of the participants in a trial by Adolphus et al. were eligible for free school meals.[14] Zipp et al.[15] mentioned that the participants in the trial were from lowest, medium, and higher SES, but did not provide additional details. The remaining trials did not report data on SES.[2,5,6,8,10,11,13]
    - The cohort study reported that most of the study participants were from households with parents employed as professionals or labor workers.[17] The cross-sectional studies did not report participants' SES.[18-20]
- Health characteristics:
    - Average Body Mass Index (BMI) of the participants in most studies was in the normal range.

[a] United Nations Development Programme. Human Development Indices and Indicators, 2016 Statistical Update. New York, 2016. Available at: http://hdr.undp.org/sites/default/files/2016_human_development_report.pdf

    - Adolphus et al.[14] reported that there were no significant differences in BMI between the breakfast and no breakfast groups. A few studies reported BMI z-scores, which ranged between 0.25[10] and 0.64.[6]
    - Kral et al.[10] noted that a third of their participants were overweight (BMI-for-age between 85th and 94th percentile). Two studies excluded subjects with BMI >95th percentile.[9,10]
    - On the other hand, Maffeis et al.[11] exclusively enrolled participants with obesity, resulting in a median BMI of 26.2 kg/m^2 and BMI z-score of 2.2. However, children did not have other overt conditions. Similarly, Peña-Jorquera et al.[20] noted that more than half of their participants were overweight or obese.
    - Fulford and Zipp et al.[8,15] did not report children's BMI. Similarly, the cohort and two cross-sectional studies did not report children's BMI.[17-19]
- Some studies excluded participants with neurological, developmental or learning disabilities[9,10,12] or explicitly mentioned that their participants did not have clinically diagnosed learning or attention disorders.[2]

Interventions/exposures

- RCTs in this body of evidence assessed acute effects of breakfast on different cognitive outcomes. All RCTs provided a cereal-based breakfast (e.g., ready-to-eat cereal, bread) to the intervention group and included a 'no breakfast' comparator group.[2,5-15]
- The NRCT assessed the association between breakfast consumption and parent's perception of alertness and cognitive function. At the beginning of the study, each child was invited to try the cereals, and was assigned to the cereal group of their choice. The non-breakfast consumers, who normally did not eat breakfast, formed the comparator group.[16]
- The cross-sectional studies[18-20] assessed the correlation between self-reported breakfast consumption and cognitive outcomes on the same day. Peña-Jorquera et al.[20] asked participants to recall their breakfast consumption on the morning of the outcome assessment. Wesnes et al.[18] also asked participants to recall habitual breakfast intake as well as breakfast consumption for that morning; but this was not using a validated tool. Benton and Jarvis[19] assessed breakfast consumption over the previous four days. In terms of the comparator, Benton and Jarvis[19] stratified breakfast caloric content for the past four days and used the group that consumed <150 kcal as their comparator; whereas, the other three studies used a 'no breakfast' comparison group.
- In the cohort study,[17] breakfast consumption at 6 years of age was stratified into two groups – breakfast consumed at least 4 days per week (exposure group) and 3 days or less (comparator group).

Outcomes and results

Neurocognitive developmental domains included the following: cognitive development (including intelligence quotient (IQ) assessment), language and communication development (including verbal IQ), movement and physical development and socio-emotional and behavioral development. Overall, there were more than 50 different tests used in 20 studies to assess four neurocognitive developmental domains. It is acknowledged that cognitive tests sometimes span across different domains and are not mutually exclusive. However, for the purposes of this review, each test is assigned to a domain based on the author's intent as stated in the article. When the domains were not specified by the author, it was assigned based on further review of the literature.

Nine of the 12 trials[2,5-7,11-15] reported at least one statistically significant finding that breakfast consumption had a beneficial effect on cognitive development in children, but all 12 articles reported at least one non-significant result (p>0.05).[2,5-15] Evidence from one NRCT,[16] one cohort[17] and three cross-sectional studies,[18-20] showed that breakfast consumption was associated with at least some aspects of cognitive outcomes. The results from the individual studies are presented in **Table 11** and discussed below.

Randomized controlled trials

Adolphus et al.[14] assessed acute effects of breakfast vs. fasting using a CANTAB test battery which included Simple Reaction Time, 5-Choice Reaction Time, Rapid Visual Information Processing (RVIP), and Paired Associates Learning (PAL). PAL test was significantly different between breakfast and fasting groups when baseline reached level 2, but it was not significant for levels 3 or 4. There was also baseline by intervention interaction for total errors made on the PAL test. There was a positive effect of breakfast on some aspects of reaction time and visual-sustained attention.

Cooper et al.[6] assessed attention using the Flanker test and Stroop test and assessed working memory using Sternberg Paradigm. While there were no significant differences between breakfast (both high and low glycemic index (GI)) and fasting groups in terms of response time and accuracy for Flanker test, there was a trial*session time interaction for response time and accuracy for low GI breakfast vs. fasting groups. In Stroop test, the low GI group had better accuracy and quicker response compared to the fasting group; however, there was no statistically significant difference between high GI vs. fasting groups. The response time was better for both high and low GI breakfast, compared to fasting; however, accuracy was better only in the low GI group and not high GI group, when compared to fasting.

In another trial, Cooper et al.[5] used visual search test, in addition to Stroop test, Strenberg Paradigm. The authors concluded that the breakfast group had a greater accuracy in visual search test (in complex level), but there were no main effects of breakfast on response time and accuracy. Similarly, there was no main effect of breakfast on Stroop test and Sternberg Paradigm's response time. However, certain aspects of both tests showed statistically significant effects (e.g., trial*session*memory load interaction for Sternberg Paradigm).

Defeyter and Russo[7] assessed attention using choice reaction time, serial subtraction and rapid visual information processing. The main effects for none of these tests were statistically significant. However, breakfast*time interaction was statistically significant only for serial subtraction, but not for other tests.

Kawabata et al.[2] assessed attention using Stroop color-word test and Go/No-Go task, and assessed working memory task using Digit Span. There was no significant difference in accuracy and reaction times between the breakfast and fasting groups at ~120 minutes for Stroop test and Digit Span. For the Go/No-Go task, the reaction time improved for the breakfast group, but this finding reversed from the middle to the end of the morning (p=0.02).

Maffeis et al.[11] measured attention using Continuous Performance Test II and noted that attention was reduced in children that skipped breakfast. Mahoney et al.[12] assessed visual attention and found no main effect in the breakfast group, compared to fasting in children 9-11 years. There was no main effect for breakfast type for hits or misses and task duration for auditory attention. However, the study showed an interaction between breakfast type and task duration, suggesting that they made fewer false alarms when the participants had breakfast. Auditory attention (hits and miss rates) was significantly different between breakfast and no breakfast groups for 6–8-year-olds, although false alarms and reaction times were not.

Widenhorn-Müller et al.[13] assessed sustained attention and noted that there were no main effects on the total number of items processed, concentration performance or number of errors. However, the authors reported that there was breakfast by group interaction for total number of items processed and concentration performance. Zipp et al.[15] assessed working memory capacity based on KAI General intelligence test and noted that the breakfast group had significantly different working memory capacity, when compared to the group without breakfast. Specifically, this was significant when children did not have breakfast at home.

In addition to the above, three RCTs found no effect of breakfast on any of their tests (decision-making task,[8] identification task,[10] detection task,[10] digit span forward,[9] CPI-II omissions total score,[9] WRAML2 processing speed index, [9] WISC-IV coding[9] and WISC-IV symbol search[9]).

Non-randomized controlled trials and observational studies

In the longitudinal study,[17] breakfast consumption at 6 years of age was significantly associated with better verbal IQ and full IQ, but not performance IQ. The NRCT[16] concluded that breakfast consumption was associated with perception of greater alertness and less cognitive difficulties. Benton et al.[19] noted that those who ate breakfast (<150 kcal) were more likely to be distracted and spend significantly less time on task than children who ate a larger meal (>150 kcal). Wesnes et al.[18] reported that participants who had breakfast were faster on the power of attention factor score, showed lower response speed variability, detected more targets and made fewer false alarms in digit vigilance task. However, there was no significant difference on choice reaction time. Peña-Jorquera et al.[20] reported that adolescents who ate breakfast before a cognitive test performed significantly better than those who did not.

Funding sources for breakfast and learning achievement and cognitive development

- Two studies were funded by the government[17,20] and one funded by the university[2]
- Three studies were co-funded by the government and industry[9,11]
- Five studies were funded by industry or private entities[7,10,14,16,18]
- Two studies were funded by industry, but the component of the study that was funded by industry was not included in this rapid review[8,19]
- Five studies had either no funding[6] or unknown funding sources.[5,12,13,15] One of the co-authors in Mahoney et al.[12] was affiliated with industry

Key Question 1b: What is the relationship between eating breakfast and weight-related outcomes?

Thirty-eight studies, including one randomized controlled trial (RCT) and 37 prospective cohort studies (PCS) examined the association between breakfast intake during childhood or adolescence and weight-related outcomes.[21-58]

To facilitate meaningful synthesis and conclusion development, this body of evidence is presented by age at baseline: childhood, early adolescence, or later adolescence. A small number of studies enrolled participants across these age periods. In these cases, the study is synthesized with the age group represented by the majority of participants, and the full age range is noted for each.

Description of the evidence - Breakfast in childhood and weight-related outcomes

Study characteristics

Sixteen PCS from eleven independent cohorts first measured breakfast intake in childhood (5-9 years).[21-24,30,35-37,43,45,47,49,52,54-56]

Seven of these studies originated from five independent US cohorts,[21-24,30,45] three from one cohort in Germany,[36,37,56] two from a single cohort in Hong Kong,[54,55] and one each from Australia,[43] China,[49] Japan,[47] and the UK.[30] Analytic sample sizes varied widely across studies, ranging from 161[43] to 68,606.[54,55]

Participant characteristics

Roughly half the studies enrolled children at ages 5-7 years,[24,30,35-37,43,45,47,56] and the remaining studies enrolled older children age 9-10 years.[21-23,49,52,54,55]

Of the eight studies that reported on race/ethnicity, roughly half enrolled a diverse sample, while the remaining studies enrolled predominantly white participants.

- The NHLBI Growth and Health Study (NGHS) cohort produced three studies in this body of evidence and enrolled roughly 50% white and 50% black participants who were all female.[21-23]
- Another study enrolled 48% Latino participants (Carlson)
- The remaining studies that reported race/ethnicity data enrolled more than two thirds white participants.[30,35,45,52]

The SES of participants in these study samples varied greatly, as did the indices used to define SES. Many studies enrolled a substantial portion of lower SES participants, evidenced by three US studies with 65% of participants reporting family income <$40,000[21-23] and another reporting 40% of the sample had an annual income <$50,000.[52] In others, 29% of participants were eligible for free school lunch,[45] and 32% of participants were considered low income (Germany: ≤ €1750/month[56]). One final study reported >80% of parents had less than thirteen years of education.[49]

Most studies reported either BMI or combined prevalence of overweight and obesity at baseline. Average BMI ranged from 16.0 kg/m^2 [37] to 18.6 kg/m^2,[22] while prevalence of overweight/obesity at baseline ranged from 4%[52] to 35%.[24]

Exposures

Twelve of the sixteen studies measured overall breakfast intake in childhood, while the remaining four studies looked at breakfast consumed at home with family,[24,43,45] at school,[45] or away from home.[55] Six of the sixteen studies measured breakfast intake at multiple time points,[21-23,30,47,52] while the remainder of studies measured it at baseline only.

Intake was parent reported for most of the younger cohorts, though the longer-term studies often transitioned to child report as the participant got older. The assessment tool varied widely across studies but most often consisted of a global measure of breakfast intake frequency that either remained continuous or dichotomized responses into ‘often/always’ representing habitual breakfast eating and ‘rarely/never’ representing breakfast skipping.

- Single item assessing habitual intake, typically over the past week or month [24,30,35-37,43,45,47,49,54-56]
- 3-day food recalls[21-23]
- 7-day dietary records measuring energy intake (EI) from 6:00-10:59AM as a percentage of total energy intake (TEI) across the day

Outcomes and results

Twelve of the studies in this body of evidence measured BMI or BMI z-scores as their outcome of interest, though a small number of studies looked at waist-to-height ratio,[37,56] prevalence of overweight and obesity,[43,47] or abdominal obesity[36] instead of or in addition to BMI. Outcome data were collected by trained researchers in all but one study where parent report was used.[47] The results described here are presented in **Table 15**, described below, and synthesized in the discussion section Evidence synthesis: Breakfast intake during childhood and weight-related outcomes.

Nine studies examined the association between overall breakfast intake and BMI or risk of overweight and obesity:

- Three studies from the same all-female, racially diverse, lower SES cohort (NHLBI Growth and Health Study)[21-23] found mixed results. Affenito et al.[21] and Barton et al.[23] found no association between average breakfast intake across repeat assessments from age 9-18 years and BMI, BMIZ, or risk of overweight (BMI ≥85th percentile) over the same follow-up period. Albertson et al.[22] stratified participants by baseline BMI percentile and found those at or above the 95th percentile at baseline with a higher average breakfast consumption across time showed significantly greater reduction in BMI at follow up nine years later.
- Gingras et al.[30] found eating breakfast daily throughout childhood (age 4-11 years) compared to breakfast ≤6 days per week was related to lower BMIZ at age 13 years in both male and female participants.
- Another study found habitual breakfast skipping in early childhood (5 years) was associated with increased odds of BMI instability over time. Specifically, those reported to regularly skip breakfast were more likely to have a significantly increasing or decreasing BMI across eight years of follow up.[35]
- Okada et al.[47] examined annual prevalence of overweight or obesity across five years of follow up (age 7-12 years) and found breakfast skipping at each age (defined as skipping ‘usually’ or ‘sometimes’) was associated with significantly greater odds of having overweight or obesity the subsequent year of follow up. For instance, breakfast skipping at age 7 years was associated with greater odds of overweight or obesity at age 8, 9, 10, 11, and 12 years. In parallel, breakfast skipping at age 9 years related to greater odds of overweight or obesity at age 10, 11, and 12 years, etc.
- Shang et al.[49] showed breakfast intake in childhood (mean age: 9 years, range 6-13 years) was not related to change in BMIZ, waist circumference, or percent fat mass across one year of follow up.

- Thompson et al.[52] assessed energy intake in the morning hours (6:00-10:59am) as a percentage of daily TEI at both baseline and at least one other time point 2-10 years later. They found no association between morning energy intake and change in BMIZ across the follow-up period (mean follow-up length: 6y, Range: 2-10 years).
- A final study examined change in BMI over two years and found habitual breakfast skipping at baseline (age 9-10 years) related to significantly greater increase in BMI across the next two years compared to those who did not skip breakfast at baseline.[54]

Three studies examined the association between breakfast intake at home with family and BMI:

- Carlson et al.[24] measured frequency of eating breakfast with family at age 6-7 years and found increased frequency was associated with decreased BMIZ over two years of follow up.
- MacFarlane et al.[43] found consuming breakfast at home daily compared to less than daily in early childhood (5-6 years) was not related to BMIZ or risk of overweight or obesity at three-year follow up.
- A third study found increased frequency of eating breakfast with family at 6 years was associated with a slower rate of BMI growth across a five-year follow up.[45]

Two studies examined the association between breakfast intake at school or away from home and BMI:

- The same study that found increased frequency of eating breakfast with family at 6 years was associated with a slower rate of BMI change found the opposite for frequency of school breakfast. Increased school breakfast consumption at 6 years related to a faster rate of BMI change across a five-year follow up period.[45]
- Tin et al.[55] found that habitual eating breakfast away from home or skipping breakfast were both related to a significantly greater increase in BMI over two years compared to participants who ate breakfast at home.

Three studies examined the association between overall breakfast intake and abdominal obesity or waist-to-height ratio:

- Three studies from the same cohort found habitually skipping versus eating breakfast at 7 years was associated with higher waist-to-height ratio at one-year follow up,[37] greater change in waist-to-height ratio across that time[56] and greater incidence of abdominal obesity at one-year follow up.[36]

Description of the evidence - Breakfast in early adolescence and weight-related outcomes

Study characteristics

Ten PCS from 10 independent cohorts first measured breakfast intake in early adolescence (~10-12 years).[25,26,29,31,32,34,43,50,51,57]

All ten studies in early adolescence represent independent cohorts, and they originated from the US,[26,51,57] the UK,[29,31] Australia,[43,50] Belgium,[32] and Brazil.[25,34] Analytic sample sizes varied widely across studies, ranging from 86[25] to 6,220.[26]

Participant characteristics

Studies in early adolescence enrolled primarily 10- and 11-year-old participants, though three studies enrolled participants across a broader range of ages, including 10-16 years,[34] 9-13 years,[51] and 9-15 years.[50] The majority of participants in those studies fell in the early adolescent age group, so they are synthesized with this body of evidence. Data on race/ethnicity and SES were rarely reported, but three of the four that did report these data enrolled diverse samples,[31,51,57] while the third enrolled predominantly white participants.[26]

Most studies reported either BMI or combined prevalence of overweight and obesity at baseline. Average BMI ranged from 22.1 kg/m^2 [25] to 24.7 kg/m^2,[31] while prevalence of overweight/obesity at baseline varied substantially across studies, ranging from 9%[50] to 42%.[34]

Exposures

Seven of ten studies in the early adolescent body of evidence assessed overall breakfast intake.[25,29,31,32,34,50,57] Two of those studies also measured breakfast consumption by location (e.g., home, school).[34,57] One additional study measured both home and school breakfast intake,[51] while the remaining two studies measured only breakfast at home.[26,43] Only three of the ten studies measured breakfast intake at multiple time points.[32,34,50]

Participants reported breakfast intake by answering either one or two questions in all studies. The assessment tool varied widely across studies but most often consisted of a global measure of breakfast intake frequency that either remained continuous or dichotomized responses into 'often/always' representing habitual breakfast eating and 'rarely/never' representing breakfast skipping.

Outcomes and results

Six studies in this body of evidence measured BMI or BMI z-score as their primary outcome of interest. Two studies measured odds of overweight/obesity, and two studies measured trunk and whole-body fatness. These outcomes were measured by training research personnel in all but one study where self-report data were used.[32] The results described here are presented in **Table 17**, discussed below, and synthesized in the discussion section Evidence synthesis: Breakfast intake during early adolescence and weight-related outcomes.

Breakfast intake and BMI or risk of overweight and obesity

- Elgar et al.[29] found no association between frequency of breakfast intake at baseline (age 11-14 years) and BMI at four-year follow up.
- A second study reported less than daily breakfast intake at 11-13 years related to higher BMI at 10-year follow up compared to daily intake.[31]
- Haerens et al.[32] found greater frequency of breakfast intake at age 10 years was associated with lower BMIZ across four years of follow up. Change in breakfast intake across those four years was not associated with BMIZ across the same period.
- Hassan et al.[34] found breakfast frequency at baseline (10-16 years) categorized as 'none', 'intermediate', or 'regular' was not related to BMIZ trajectory across three years of follow up. Persistence in breakfast habits between baseline and 3-year follow up was also not related to BMIZ trajectory across the same period.
- An additional study found breakfast skipping compared to daily breakfast intake at 10-12 years did not relate to BMIZ at 3-year follow up but did relate to risk of overweight/obesity. Breakfast skipping was significantly related to increased odds of overweight or obesity at follow up.[43]
- Smith et al.[50] found breakfast skipping in 9- to 15-year-olds was related to significantly higher BMI at 21-year follow up.

Breakfast intake at home with family and BMI or risk of overweight and obesity

- Chang and Gable[26] found frequency of breakfast at home with family at baseline (5th grade) was not associated with change in weight status over three years of follow up.
- Hassan et al.[34] found frequency of breakfast with family at baseline (10-16 years) categorized as 'none', 'intermediate', or 'regular' was not related to BMIZ trajectory across three years of follow up. Persistence in breakfast with family habits between baseline and 3-year follow up was also not related to BMIZ trajectory across the same period.
- Wang et al.[57] examined breakfast intake across contexts at baseline (5th grade), including home and school, as well as participants who ate breakfast at both locations (double breakfast eaters). They found that relative to double breakfast eaters, those who skipped breakfast, inconsistently ate breakfast at school or home, or regularly at breakfast at home were all significantly more likely to be overweight or have obesity across a two-year follow up.

Breakfast intake at school and risk of overweight and obesity

- Sudharsanan et al.[51] looked specifically at school breakfast consumption at baseline (5th grade) and found no difference in obesity prevalence or change in obesity status by 8th grade between participants who had no school breakfast versus any. The same absence of association was found for family breakfast frequency at baseline.
- Wang et al.[57] examined breakfast intake across contexts, including home and school, as well as participants who ate breakfast at both locations (double breakfast eaters). They found that relative to double breakfast eaters, those who skipped breakfast, inconsistently ate breakfast at school or home, or regularly at breakfast at home were all significantly more likely to be overweight or have obesity across a two-year follow up.

Breakfast intake and trunk or whole-body fatness

- Cayres et al.[25] found a higher average frequency of breakfast intake across baseline and 1-year follow-up measures related to a significantly greater decrease in trunk and whole body fat over the same follow up period. When physical activity was entered as a mediator, the association between breakfast intake and whole-body fatness remained significant, while the association between breakfast and truck fatness did not.
- Hassan et al.[34] found female intermediate breakfast consumers (1-4 days per week) at baseline (10-16 years), as well as those females who persisted as irregular breakfast consumers across the follow-up period, showed smaller increases in percent body fat across that same period. No significant association was found for overall breakfast intake in male participants. However, results were mixed for frequency of family breakfast, with female 'intermediate' family breakfast consumers at baseline showing a smaller increase in percent body fat across time, while males did not. And conversely, male participants who had inconsistent breakfast with family across the follow-up years had larger decreases in percent body fat compared to those who regularly ate family breakfast across time; and the association was non-significant for females.

Description of the evidence – Breakfast in later adolescence and weight-related outcomes

Study characteristics

One RCT and 12 PCS from 6 independent cohorts first measured breakfast intake in later adolescence (13-18 years).[27,28,33,38-42,44,46,48,53,58]

The majority of studies from later adolescence were conducted in the US,[27,33,39-42,44,46,48,53] with one each in Korea,[38] the Netherlands,[28] and Sweden.[58] The RCT analyzed data for 105 participants (ITT; Kim, 2021),[38] while the PCS analyzed sample sizes ranging from 562[39] to 13,568.[41]

Participant characteristics

At enrollment, most studies in this body of evidence enrolled participants that were 15-16 years old, on average. However, roughly half of the studies enrolled a broad range of ages from 12-20 years.[27,33,38-41,44]

Of the 10 studies reporting race/ethnicity data:

- Five studies from the Add Health cohort examined predominantly white participants (59-69%)[27,40,41,44,46]
- Three studies from the Project EAT cohort examined ~50% white, ~20% black, and ~20% Asian participants[33,48,53]
- An additional study enrolled 56% white, 20% black, and 19% Hispanic participants[42]
- The final study reporting race/ethnicity data enrolled 87% white participants[39]

Data on SES were reported infrequently in this body of evidence, and the scales and definitions used varied greatly across studies.

- The Add Health cohort studies reported a range of SES outcomes, including >60% of families with low SES,[40] 37-46% of parents having high school education or less,[41,46] and 14% of families below the poverty line[44]
- The Project EAT studies reported ~35% of enrolled families had low or low-middle SES[33,48]
- The Northern Swedish cohort enrolled ~39% participants with low SES, while the remaining study reporting SES data enrolled higher-SES participants (5.4 on a 0-7 scale of affluence)[42]

Most studies reported either BMI or combined prevalence of overweight and obesity at baseline. Average BMI ranged from 19.5 kg/m^2[58] to ~25 kg/m^2,[38] while prevalence of overweight/obesity at baseline ranged from 9%[28] to 29%.[46]

Interventions/exposures

The RCT randomized participants to one of three breakfast groups: rice-based, wheat-based, or general (usual consumption control group). Participants were provided the breakfast meals on weekdays only for 12 weeks, and compliance was monitored using meal consumption data.

All cohort studies that enrolled participants in later adolescence measured overall breakfast intake, though the cutoff used to distinguish breakfast eaters from skippers varied across studies. Repeat assessment of breakfast intake was more common in this body of evidence than in younger populations, with eight of 12 studies measuring breakfast intake at least twice during the follow-up period, though one study only used baseline data,[28] and the remaining four studies measured intake at baseline only.[27,40,41,58] No context-specific measures (e.g., breakfast at home or school) were included in this body of evidence.

- All but one study assessed breakfast intake with a single self-report question[27,28,33,40,41,44,48,53,58]
    - Two studies further defined a poor breakfast habit as eating nothing at all or eating a poor quality breakfast (i.e., only eating something sweet (e.g., bun, cookie) or drinking something energy-containing)[58] or as eating nothing at all or only a glass of milk or fruit juice[42]

    - One study only assessed weekday breakfast intake[41]

- The remaining study used a 3-day dietary record and defined breakfast intake as a meal called ‘breakfast’ containing ≥50 kcal[39]

Outcomes and results

The RCT looked at the outcomes of BMI, percent fat mass, and waist-to-hip ratio. Though there were significant differences across groups in the amount of change in BMI, body fat mass, and percent fat mass at the end of 12 weeks, there were no significant between-group differences in these outcomes.[38] The results described here are presented in **Table 19**, described below, and synthesized in the discussion section Evidence synthesis: Breakfast intake during later adolescence and weight-related outcomes.

All but one cohort study examined BMI or the incidence or prevalence of overweight and obesity as the outcome of interest. The remaining study focused on abdominal obesity.[58] Self-reported outcome measures were more common in this body of evidence, with six studies relying on participant reports of height and weight for at least one time point.[33,40-42,44,48,53]

Overall breakfast intake and BMI, overweight, or obesity in cohort studies:

- The five studies from the Add Health cohort found mixed results:
    - Crossman et al.[27] found breakfast skipping at baseline (12-20 years) was associated with BMI at 6-year follow up in males but not in females.
    - Lee et al.[40] found breakfast skipping at baseline (skipping breakfast ‘usually’ or 5-7 days per week) related to obesity persistence across the 6-year follow up in both males and females, while breakfast skipping at baseline related to higher obesity incidence in males but not females.
    - Liechty and Lee[41] found weekday breakfast skipping in adolescence did not relate to overweight incidence in males at 1-year follow up; however, in females there was a significantly increased risk of overweight both before and after adjusting for BMIZ.
    - Merten et al.[44] examined patterns of consistency and inconsistency in breakfast intake at baseline (12-19y) and follow up (18-26 years) and their association with chronic obesity (defined as both ≥95th percentile at baseline and >30 kg/m^2 at follow up). Participants who ate breakfast irregularly (<4 times per week) were more likely to have chronic obesity than those who ate breakfast more regularly.
    - Niemeier et al.[46] examined breakfast intake frequency over the past week at both baseline and 5-6y follow up and found that greater frequency of breakfast intake at baseline and greater intake in breakfast intake frequency from baseline to follow up were both associated with lower BMIZ at follow up.
- The Project EAT studies found consistently beneficial associations with breakfast intake:
    - Haines et al.[33] assessed prevalence of overweight at 5-year follow up and found greater frequency of breakfast intake at baseline was associated with reduced prevalence of overweight. Greater increase in frequency of breakfast intake from baseline to follow up also related to lower incidence of overweight at five years.

- A longer-term study of this cohort examined the same association and found greater frequency of breakfast intake at baseline was associated with reduced prevalence of overweight at 10-year follow up, but in females only.[48]
- A third study examined a more nuanced breakfast categorization and discovered both intermittent breakfast consumers and breakfast skippers showed a significantly greater BMI increase over 5-year follow up compared to daily breakfast consumers.[53]

- De Winter et al.[28] found skipping breakfast compared to regularly consuming breakfast (≥5 days per week) did not relate to incidence of overweight and obesity at 1-4-year follow up.
- Another study measured breakfast intake at baseline and 2-year follow up using 24-hour dietary recalls. They determined the percent of three recall days containing a meal called 'breakfast' containing ≥50 kcal was not associated with BMI at 2-year follow up, either with or without adjustment for TEI.[39]
- Lipsky et al.[42] found no association between frequency of breakfast skipping (eating nothing at all or no more than a glass of milk or fruit juice) measured annually across four years and change in BMI over the same period of follow up.

Overall breakfast intake and abdominal obesity

- Wennberg et al.[58] found that skipping breakfast entirely or eating a poor-quality breakfast (e.g., bun, cookie, beverage) at baseline was not associated with prevalence of abdominal obesity at 27-year follow up.

Key Question 1c: What is the relationship between eating breakfast and health?

This body of evidence included 19 articles: eight randomized controlled trials (RCT), one non-randomized controlled trial (NRCT), and 10 prospective cohort studies (PCS).

To facilitate meaningful synthesis and conclusion development, this body of evidence is presented by outcome category:

1. Physiological effects of breakfast consumption,
2. Breakfast consumption and longitudinal cardiometabolic health outcomes, and
3. Breakfast consumption and longitudinal mental health outcomes.

Description of the evidence – Physiological effects of breakfast consumption

Study characteristics

Seven randomized controlled trials, including five crossover studies[7,10,11,13,59] and two parallel studies,[2,14] examined outcomes measured following a breakfast meal.

The studies were conducted in the United States,[10,59] United Kingdom,[7,14] Germany,[13] Italy,[11] and Singapore.[2]

The studies had small analytic samples (10 to 104 participants), which is expected because each participant in a crossover study serves as his or her own control.

Participant characteristics

Participant age is described for each study below. Other participant characteristics are noted, when they were part of the sampling strategy (e.g., pubertal status, weight status, breakfast habit, socioeconomic status), or when they were notable (e.g., majority female, majority African American). Participants were:

- Prepubescent nine-year-olds with obesity,[11]
- Nine-year-olds who were predominantly female (71%), African American (76%), habitual breakfast consumers (90%), and had a normal to overweight BMI,[10]
- Twelve-year-olds who were mostly of low socioeconomic status (68% eligible for free school meals),[14]
- Fourteen-year-olds of low socioeconomic status who were habitual breakfast skippers with a normal BMI,[7]
- Fourteen-year-old habitual breakfast skippers with a normal to overweight BMI,[59]
- Predominantly female (78%) 16-year-olds with a normal BMI,[2] and
- Seventeen-year-olds who were predominantly (88%) habitual breakfast consumers.[13]

Interventions

All seven studies compared one or two breakfast conditions to a fasting condition. In every study, participants in the fasting condition received water.

- Six studies had one breakfast condition:
  - Adolphus et al.[14] fed participants ready-to-eat breakfast cereal (corn flakes, toasted rice, sugar-topped shredded whole wheat, or wheat/corn/oat shapes) with 1.8% fat cow's milk *ad libitum* up to

70g cereal and 300 mL milk (kcal and macronutrients varied depending on intake).

- Defeyter and Russo[7] fed participants 35g Allbran plus 125mL skim milk (kcal and macronutrients were not reported).
- Kawabata et al.[2] fed participants two slices of multi-grain bread with 20g Nutella, and a chocolate malt powder drink (382 kcal, 52.7g carbohydrate, 12.4g fat, 14.3g protein). The intervention in this study also included 30 minutes of exercise 30 minutes before the experimental conditions.
- Kral et al.[10] fed participants a 350 kcal breakfast consisting of 32g ready-to-eat breakfast cereal, 192g 1% milk, 60g banana, and 187g orange juice, which (depending on the breakfast cereal) had a total of 9.9-12.4g protein, 68.0-69.1g carbohydrates, 3.3-5.1g fat, 2.6-3.9g fiber, and 42.9-45.9g sugar.
- Maffeis et al.[11] fed participants 200mL whole milk, 31.6g toasted bread, and 25g marmalade (295kcal, 13% protein, 27% lipid, 60% carbohydrates).
- Widenhorn-Müller et al.[13] fed participants 60g whole wheat bread, 20g butter, 20g Nutella, 30g strawberry jam, and *ad libitum* water and unsweetened peppermint tea which had a total of 992kJ carbohydrates, 103kJ protein, and 895kJ fat.

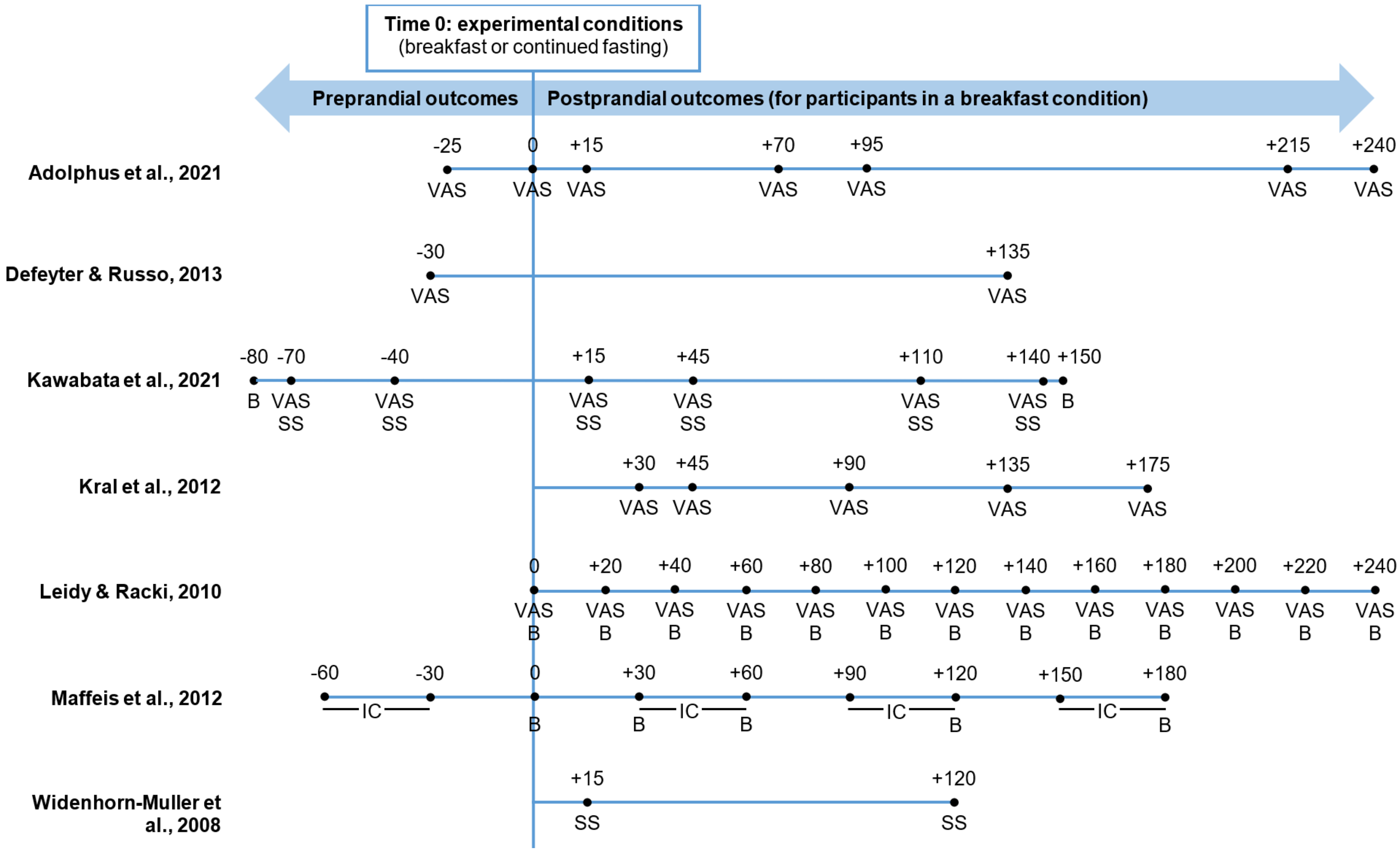
- Leidy and Racki[59] had two breakfast conditions (normal-protein and protein-rich), but also studied the effect of breakfast across both conditions for some outcomes. The normal-protein and protein-rich breakfast conditions both consisted of pancakes with butter and syrup, scrambled eggs with cheese, and 266mL water, and the participants rated them equally palatable. The two breakfast conditions were isocaloric (513kcal) and had the same amount of lipids (13%), fiber, sugar, and energy density, but the normal-protein condition had 14% protein and 73% carbohydrates whereas the protein-rich condition had 38% protein and 49% carbohydrates.

Outcomes and results

The timing of each outcome measure is described relative to the timing of the intervention (**Figure 4**).

The results described here are presented in **Table 22** and synthesized in the discussion section Evidence synthesis: Physiological effects of breakfast consumption.

Figure 4. Outcome measure timing in relation to the intervention in studies that examined the physiological effects of breakfast consumption
Experimental conditions (breakfast or continued fasting) occurred at time 0 (vertical line). Outcome measures (dots on the horizontal lines for each study) occurred before and after time 0. Negative numbers represent the number of minutes before time 0 and positive numbers represent the number of minutes after time 0. Outcomes measured before time 0 were preprandial (pre-meal) outcomes, and outcomes measured after time 0 were postprandial (post-meal) outcomes for participants allocated to a breakfast condition. Abbreviations: VAS: visual analog scale, B: blood draw, IC: indirect calorimetry, SS: subjective scale.



Perceived hunger, appetite, satiety, and fullness

Four studies measured perceived hunger, appetite, satiety, and/or fullness using visual analog scales.[2,7,14,59] Participants placed a mark on a horizontal 100mm line to indicate their hunger, appetite, satiety, or fullness someplace from the lowest level on the left to the highest level on the right.

- Two studies assessed the effect of breakfast or fasting on hunger[14] or on appetite and satiety[59] at specific points in time.
  - Adolphus et al.[14] reported that participants in the breakfast condition had significantly lower hunger than participants in the fasting condition at +15, +70, +95, +215, and +240 minutes (15, 70, 95, 215, and 240 minutes after time 0 when participants in the breakfast condition were fed).
  - Likewise, Leidy and Racki[59] reported that participants in the normal-protein and high-protein breakfast conditions had a significantly lower appetite and higher satiety at +20 and +240 minutes than participants in the fasting condition.
- One study[2] assessed the effect of breakfast or fasting on the change in hunger, appetite, satiety, and fullness from -70 to +15 and +140 minutes. However, participants in the breakfast condition reported higher hunger and lower satiety and fullness at baseline than participants in the fasting condition (at -70 minutes). Since participants did not start at a similar level of hunger, satiety, or fullness, it is difficult to interpret the findings after the conditions were implemented. Therefore, these findings will not be considered in the evidence synthesis.
- Two studies examined the interaction of the experimental conditions and time on hunger[7,14] and satiety,[7] or how the effect of breakfast or fasting on hunger and satiety changed depending on time. Adolphus et al.[14] measured hunger at -25, 0, +15, +70, +95, +215, and +240 minutes, while Defeyter and Russo[7] measured hunger and satiety at -30 and +135 minutes.
  - Adolphus et al.[14] reported a significant interaction effect of the experimental conditions*time on hunger. Hunger increased in both conditions across the study, but it increased in a less pronounced way in the breakfast condition (which had an initial decrease in hunger at +15 minutes after being fed) than in the fasting condition.
  - Likewise, Defeyter and Russo[7] reported significant interaction effects of the experimental conditions*time on hunger and satiety. Hunger decreased and satiety increased in both conditions across the study, but hunger decreased and satiety increased in a more pronounced way in the breakfast condition than in the fasting condition.
- One study assessed the global effect of breakfast or fasting on appetite and satiety during the study period. Leidy and Racki[59] measured appetite and satiety every 20 minutes from time 0 to +240 minutes to calculate the area under the curve (AUC) for the entire 240-minute period. The appetite AUC was significantly lower and the satiety AUC was significantly higher in the breakfast conditions (normal-protein and high-protein breakfast conditions combined) than in the fasting condition. Further exploration of these relationships revealed that the protein-rich breakfast condition resulted in a significantly lower appetite AUC but the normal-protein breakfast condition did not. On the other hand, both the normal-protein and protein-rich breakfast conditions resulted in a significantly higher satiety AUC.

Perceived mood

This section describes outcomes measured following a breakfast meal. See the section Description of the evidence: Breakfast consumption and longitudinal mental health outcomes for longitudinal outcomes.

Four studies measured perceived mood.[2,7,10,13] Two of the studies used visual analog scales, which Defeyter & Russo[7] used to assess alertness, calmness, and contentment (the Bond-Lader mood scale[a]) and which Kral et al.[10] used to assess energy level, tiredness, well-being, and cheerfulness. The other two studies used a variety of subjective scales. Widenhorn-Müller et al.[13] used the Mood Assessment Scale[b] to assess 15 outcomes classified into five dimensions of mood: negative affect (depressed, unhappy, queasy), positive affect (happy, well, cheerful), information update (fascinated, interested, uninterested), arousal (calm, nervous, agitated), and alertness (tired, sleepy, awake). Kawabata et al.[2] used different scales to assess motivation, arousal, feeling, and mental effort. Motivation was assessed using a 10-point scale from "not interested at all" to "very interested". Arousal was assessed using the 6-point Felt Arousal Scale[c] ("low arousal" to "high arousal"). Feeling was assessed using the 11-point Feeling Scale[d] ("very bad" to "very good"). Mental effort was assessed using the Rating Scale for Mental Effort,[e] which ranged from 0 to 150 points with nine anchors, including "no effort at all" at 3, "a fair amount of effort" at 58, and "extreme effort" at 114 points.

- One study assessed the effect of breakfast or fasting on mood at specific points in time. Widenhorn-Müller et al.[13] reported that participants in the breakfast condition had significantly lower negative affect at +15 minutes, significantly higher positive affect at +15 and +120 minutes, significantly higher information uptake at +15 minutes, and significantly higher alertness at +15 and +120 minutes than participants in the fasting condition. The differences in positive affect and information uptake were driven by significant differences among male students, whereas the difference in alertness was driven by significant differences among female students.
- One study[2] assessed the effect of breakfast or fasting on the change in mood outcomes across the morning. The study assessed the change in arousal and feeling from -70 to +15 and +140 minutes. The study also assessed the effect of breakfast or fasting on changes in motivation preceding each of three cognitive tests described in the section Results for Key Question 1a: What is the relationship between eating breakfast and school performance? (from -70 to +15 and +110 minutes) and changes in mental effort following those three cognitive tests (from -40 to +45 and +140 minutes). Participants in the breakfast condition reported a larger increase in feeling (towards the "very good" end of the scale) from -70 to +15 minutes than participants in the fasting condition, but the change across the rest of the morning did not differ significantly between groups. Change in mental effort differed significantly between groups from -40 to +45 minutes; participants in the breakfast condition reported a decrease in mental effort whereas participants in the fasting condition reported an increase. Change in arousal and motivation across the morning did not differ significantly between groups.
- Two studies examined the interaction of the experimental conditions and time on mood outcomes,[7,10] or how the effect of breakfast or fasting on mood outcomes changed depending on time. Defeyter and Russo[7] measured outcomes at -30 and +135 minutes, while Kral et al.[10] measured outcomes at +30, +45, +90, +135, and +175 minutes.
    - Defeyter and Russo[7] reported significant interaction effects of the experimental conditions*time on alertness, calmness, and contentment. Alertness and contentment increased across the study in the breakfast condition but decreased in the fasting condition. Calmness decreased in both

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[a] Bond A, Lader M. The use of analogue scales in rating subjective feelings. *British Journal of Medical Psychology*. 1974;47(3):211-218. https://doi.org/10.1111/j.2044-8341.1974.tb02285.x.

[b] Feist A, Stephan E. *Verfahren zur Erfassung des Gefühlszustandes [Mood Assessment Scale; in German]*. Cologne, Germany: University of Cologne; 2004.

[c] Svebak S, Murgatroyd S. Metamotivational dominance: A multimethod validation of reversal theory constructs. *J Pers. Soc. Psychol.* 1985;48(1):107–116. https://doi.org/10.1037/0022-3514.48.1.107.

[d] Hardy CJ, Rejeski WJ. Not What, but How One Feels: The Measurement of Affect during Exercise. *J. Sport Exerc. Psychol.* 1989;11(3):304–317. https://doi.org/10.1123/jsep.11.3.304.

[e] Zijlstra FRH. *Efficiency in Work Behavior: A Design Approach for Modern Tools*. Delft, The Netherlands: Delft University Press: 1993.

conditions across the study, but it decreased in a more pronounced way in the fasting condition.

- Kral et al.[10] reported nonsignificant interaction effects of the experimental conditions*time on perceived energy level, tiredness, well-being, and cheerfulness.
- Both studies reported significant main effects of breakfast (independent of time) on some outcomes: Defeyter and Russo[7] reported favorable main effects of breakfast on alertness, calmness, and contentment, and Kral et al.[10] reported favorable main effects of breakfast on cheerfulness and energy level. This suggests that simply being allocated to the breakfast condition may have impacted mood outcomes, which could be due to a lack of participant blinding (participants may have been in a better mood if they knew they would eat breakfast).

Glucose, triglycerides, and hormones

This section describes outcomes measured following a breakfast meal. See the section Description of the evidence: Breakfast consumption and longitudinal cardiometabolic health outcomes for longitudinal outcomes.

Three studies measured glucose, triglycerides and/or hormones from blood.[2,11,59] Kawabata et al.[2] used a finger stick, while Leidy and Racki[59] and Maffeis et al.[11] inserted an IV catheter into the antecubital vein of participants' arms to allow for repeated blood draws across the study period.

- Two studies assessed the effect of breakfast or fasting on triglycerides and/or glucose:
  - Kawabata et al.[2] measured glucose at -80 and +150 minutes to assess the effect of breakfast or fasting on the change in glucose across the study period. Participants in the fasting condition had a greater change in glucose than participants in the breakfast condition from -80 to +150 minutes, which was a net decrease.
  - Maffeis et al.[11] measured glucose and triglycerides at 0, +30, +60, +120 and +180 minutes to assess the effect of breakfast or fasting at each time point, as well as the global effect across the 180-minute using AUC. Participants were similar at time 0, but glucose was significantly higher in the breakfast condition than in the fasting condition at +30, +120, and +180 minutes, and triglycerides were significantly higher in the breakfast condition than in the fasting condition at +60, +120, and +180 minutes. Likewise, the glucose AUC and triglycerides AUC were significantly higher in the breakfast condition.
- One study assessed the effect of breakfast or fasting on insulin and glucagon, which are hormones that synthesize glycogen from glucose in a fed state and break down glycogen into glucose in a fasting state, respectively. Maffeis et al.[11] measured insulin and glucagon at 0, +30, +60, +120 and +180 minutes to assess the global effect of breakfast or fasting across the 180-minute using AUC. The insulin AUC was significantly higher, and the glucagon AUC was significantly lower, in the breakfast condition than in the fasting condition.
- Two studies assessed the effect of breakfast or fasting on ghrelin, peptide YY (PYY), and/or glucagon-like peptide-1 (GLP-1). Ghrelin is an appetite-stimulating (hunger) hormone that is higher in a fasted state, while PYY and GLP-1 are appetite-suppressing (satiety) hormones that are higher in a fed state.
  - Leidy and Racki[59] measured active ghrelin and total PYY every 20 minutes from time 0 to +240 minutes to assess the effect of breakfast or fasting at +20 and +240 minutes and across the 240-minute period with AUC.

    The active ghrelin AUC was lower in participants fed breakfast (inclusive of both normal-protein and protein-rich conditions) than in participants in the fasting condition, but it was not statistically significant. Likewise, the normal-protein or protein-rich breakfast conditions were not significantly related to active ghrelin at +20 or +240 minutes.

On the other hand, the PYY AUC was significantly higher in participants fed breakfast (inclusive of both normal-protein and protein-rich conditions) than in participants in the fasting condition. Further exploration of this relationship revealed that the PYY AUC was significantly higher in both the normal-protein and protein-rich breakfast conditions. In addition, PYY was higher at +20 and +240 minutes in the protein-rich breakfast condition than the fasting condition (the normal-protein breakfast condition was not reported).

- Maffeis et al.[11] measured total ghrelin (active as well as inactive), PYY, and GLP-1 at 0, +30, +60, +120, and +180 minutes to assess the global effect of breakfast or fasting across the 180-minute period with AUC.

  The total ghrelin AUC was a significantly lower in the in the breakfast condition than in the fasting condition. The PYY AUC and GLP-1 AUC were higher in the breakfast condition than in the fasting condition, but these results were not statistically significant.

Resting energy expenditure and macronutrient oxidation

One study[11] examined the effect of breakfast or fasting on resting energy expenditure and macronutrient oxidation rates (markers of the metabolism of carbohydrates, lipids, and proteins) using indirect calorimetry. Participants rested under a transparent ventilated hood that measured their respiration and the exchange of O_2 and CO_2. Resting energy expenditure and macronutrient oxidation rates were calculated from O_2 consumption and CO_2 production using appropriate formulas. Indirect calorimetry occurred during a 30-minute period before time 0 and during 3 periods after time 0 (-60 to -30, +30 to +60, +90 to +120, and +150 to +180 minutes).

All participants had similar REE and macronutrient oxidation before the experimental conditions were administered. After being fed, participants in the breakfast condition had significantly higher REE and carbohydrate oxidation than participants in the fasting condition, and participants in the fasting condition had significantly higher lipid oxidation. Participants had similar protein oxidation.

Description of the evidence – Breakfast consumption and longitudinal cardiometabolic health outcomes

Study characteristics

Eight prospective cohort studies[30,31,49,50,58,60-62] examined associations between breakfast consumption and longitudinal cardiometabolic health outcomes.

The studies were conducted in the United States,[30,60] United Kingdom,[31] Switzerland,[61] Sweden,[58] Australia,[50] and China,[49] and there was a multi-national study conducted in Belgium, Cyprus, Estonia, Germany, Hungary, Italy, Spain, and Sweden.[62]

The studies had analytic samples of between 223 and 6,964 participants.

Participant characteristics

The age of participants across the observation period, and participant breakfast habit (when reported), are described for each study below. Other participant characteristics are described when they were part of the sampling strategy (e.g., representative of London), or when they were notable (e.g., mostly white, highly educated mothers). Participants were:

- Children observed from age four to 13 years who were mostly habitual breakfast consumers (~85%), mostly white (65%), and mostly from households with incomes >$70,000/year (64%) and college-educated mothers (71%),[30]

- Eleven- to 13-year-olds from a diverse sample representative of the city of London, who were mostly habitual breakfast consumers (63%) and observed until age 22 years,[31]
- Adolescents who were mostly white (82%) and who were observed from about 15 to 16 years of age,[60]
- Children who were observed from age eight to 12 years who were mostly habitual breakfast consumers (93%),[61]
- Six- to 13-year-olds observed for one year who were mostly habitual breakfast consumers (84%), and mostly from families with parents who had up to 12 years of education (66% of mothers, 67% of fathers),[49]
- Nine- to 15-year-olds from a sample representative of the nation of Australia who were observed until age 28 to 36 years,[50]
- Sixteen-year-olds from a sample representative of the nation of Sweden who were mostly habitual breakfast consumers (90%) and who were observed to age 43 years,[58] and
- Children from a multi-national European sample with an average breakfast frequency of six days per week, who were observed from age six to eight years.[62]

Exposures

Five studies examined breakfast consumption at baseline, only.

- Goff et al.[31] compared 11- to 13-year-olds who self-reported consuming breakfast fewer than five days per week with those who reported consuming breakfast every day.
- Meyer et al.[61] compared children (mean age 8.71 years) whose parents reported that they skipped breakfast at least two days per week with children whose parents reported that they did not skip breakfast at least two days per week.
- Shang et al.[49] compared breakfast frequencies of zero, one to six, and seven days per week, which was self-reported by six- to 13-year-old participants with the help of their parents or tutors.
- Smith et al.[50] compared nine- to 15-year-olds who self-reported that they usually eat something before school with those who reported that they do not.
- Wennberg et al.[58] compared 16-year-olds who self-reported consuming no breakfast or consuming foods/beverages that did not meet the study's definition of breakfast (i.e., a caloric drink or something sweet), collectively classified as "poor breakfast habits", with those who reported consuming other food items, classified as "eating breakfast".

Three studies examined breakfast consumption across the observation period.

- Gingras et al.[30] compared eating breakfast daily with eating breakfast six or fewer days per week throughout childhood (ages four through 10 years). Breakfast frequency was reported by mothers when children were four through eight years old, and self-reported by participants at ages nine and 10 years, on a yearly questionnaire.
- Kim et al.[60] examined "usually skipping breakfast" from a mean age of 14.9 through 16.2 years, which was self-reported by students in the fall and spring of two sequential school years.
- Zaqout et al.[62] examined change in breakfast frequency (times/week) from a mean age of six years to eight years, which was parent-reported using a food frequency questionnaire.

Outcomes and results

The results described here are presented in **Table 24** and synthesized in the discussion section Evidence synthesis: Breakfast consumption and longitudinal cardiometabolic health outcomes.

Metabolic syndrome

Three studies examined metabolic syndrome, which is a name given to a cluster of risk factors for cardiovascular disease, type 2 diabetes, and related cardiometabolic outcomes. The studies used similar definitions of metabolic syndrome, which were based upon waist circumference/central obesity, triglycerides, HDL cholesterol, fasting glucose, and blood pressure.

- Meyer et al.[61] assessed high cardiovascular risk at a mean age of 12.59 years, which was defined as the highest tertile of a score calculated by averaging the z-scores for the five components of the metabolic syndrome: waist circumference, the mean of systolic and diastolic blood pressure, glucose, inverted HDL cholesterol, and triglycerides. All components were measured at school after an overnight fast. High cardiovascular risk at age 12 years did not differ significantly between participants who did and did not skip breakfast at least two days per week at age eight years.
- Smith et al.[50] calculated a continuous metabolic syndrome score at age 28 to 36 years, which was derived from a sex-specific principal components analysis. Two principal components (with eigenvalues ≥1.0) were identified that explained 34% and 26% of the variance in men and 31% and 25% of the variance in women: (1) waist circumference, fasting triglycerides, and HDL cholesterol, and (2) fasting glucose and blood pressure. The principal components were summed and weighted according to the relative proportion of variance explained. The continuous metabolic syndrome score at 28 to 36 years did not differ significantly between participants who reported “yes” and participants who reported “no” to the question “do you usually eat something before school” at age nine to 15 years (all participants reported eating breakfast at age 28 to 36 years).
- Wennberg et al.[58] defined metabolic syndrome at age 43 years as central obesity (≥80cm for women and 94cm for men), plus at least two of the following: increased triglycerides (≥1.7mmol/L) or specific treatment for that lipid abnormality, reduced HDL cholesterol (<1.29mmol/L for women and 1.03mmol/L for men) or specific treatment for that lipid abnormality, increased blood pressure (systolic ≥130mmHg or diastolic ≥85mmHg), and/or increased fasting glucose (≥5.6mmol/L) or diagnosed type 2 diabetes. Participants classified as having “poor breakfast habits” at age 16 years had significantly higher odds of metabolic syndrome at age 43 years than participants classified as “eating breakfast”.

Blood lipids, glucose, and insulin

This section describes longitudinal outcomes. See the section Description of the evidence: Physiological effects of breakfast consumption for outcomes measured following a breakfast meal.

Five studies examined blood lipids, glucose, and insulin.

- Gingras et al.[30] assessed insulin resistance [homeostatic model assessment for insulin resistance (HOMA-IR)] at a mean age of 13 years, stratified by sex. In males, eating breakfast daily throughout childhood (from age 4 through 10 years), compared with six or fewer days per week, was associated with a significantly lower HOMA-IR. In females, the association was in the same direction but lacked statistical significance.
- Goff et al.[31] assessed total and HDL cholesterol at a mean age of 22 years, which was not significantly associated with eating breakfast fewer than 5 days per week, compared with daily, at age 11 to 13 years.
- Shang et al.[49] assessed the changes in total cholesterol, HDL cholesterol, LDL cholesterol, the ratio of total:HDL cholesterol, triglycerides, and fasting glucose from baseline, when participants were six to 13 years old, to the one-year follow-up visit. The changes in HDL cholesterol and total:HDL cholesterol were significantly different across the three exposure groups, which reported breakfast frequencies of zero, one to six, or seven days per week. HDL cholesterol increased in all breakfast frequency groups, but increased the most in participants who reported eating breakfast seven days per week. Likewise, total:HDL cholesterol decreased in all breakfast frequency groups, but decreased the most in

participants who reported eating breakfast seven days per week. The changes in total cholesterol, LDL cholesterol, triglycerides, and fasting glucose were not statistically different across breakfast frequencies.

- Smith et al.[50] assessed fasting triglycerides, total cholesterol, LDL cholesterol, HDL cholesterol, glucose, and insulin at 28 to 36 years, and calculated HOMA-IR. None of these outcomes differed significantly between participants who reported "yes" and participants who reported "no" to the question "do you usually eat something before school" at age nine to 15 years (all participants reported eating breakfast at age 28 to 36 years).
- Wennberg et al.[58] assessed high triglycerides (≥1.7mmol/L, or specific treatment for that lipid abnormality), low HDL cholesterol (<1.29mmol/L for women and 1.03mmol/L for men or specific treatment for that lipid abnormality), and high fasting glucose (≥5.6mmol/L or diagnosed type 2 diabetes). Participants classified as having "poor breakfast habits" at age 16 years had significantly higher odds of high fasting glucose at age 43 years than participants classified as "eating breakfast". The odds of high triglycerides and low HDL cholesterol at age 43 years were not significantly associated with breakfast at age 16 years.

Blood pressure

Four studies examined blood pressure.

- Goff et al.[31] assessed systolic blood pressure at a mean age of 22 years, which was not significantly associated with eating breakfast fewer than 5 days per week, compared with daily, at age 11-13 years.
- Kim et al.[60] examined the increases in systolic blood pressure and diastolic blood pressure over the two-school-year observation period (from a mean age of 14.9 to 16.2 years). An increase in "usually skipping breakfast" across the same period was associated with a significant increase in systolic, but not diastolic, blood pressure.
- Shang et al.[49] assessed the changes in systolic and diastolic blood pressure from baseline (when participants were six to 13 years old) to the one-year follow-up visit. The changes in systolic and diastolic blood pressure did not differ significantly between participants who reported eating breakfast zero, one to six, or seven days per week at baseline.
- Wennberg et al.[58] assessed high blood pressure (systolic ≥130mmHg or diastolic ≥85mmHg) at age 43 years. The odds of high blood pressure at age 43 years was not significantly associated with having "poor breakfast habits" at age 16 years compared with "eating breakfast".

Fitness

Zaqout et al.[62] examined change in cardiorespiratory fitness, muscular strength, speed, flexibility, and balance from a mean age of six years to eight years. Change in cardiorespiratory fitness was assessed using the number of shuttles run during progressive 20-meter shuttle runs, and by calculating the maximal oxygen consumption (VO2max) from the number of shuttles run. Change in muscular strength was assessed using handgrip strength and a standing long jump. Speed was assessed with a 40-meter sprint. Flexibility was assessed with a sit-and-reach test. Balance was assessed with a flamingo balance test, which measured the number of participant attempts before successfully standing on one leg for one minute with the other leg bent at the knee with the foot held by the hand on the same side.

The study found a significant correlation between an increase in breakfast frequency from six years to eight years and an increase in the number of seconds to complete a 40-meter sprint (i.e., worse speed) over the same period. There were no significant associations between change in breakfast frequency and change in the measures of cardiorespiratory fitness, muscular strength, flexibility, or balance.

Description of the evidence – Breakfast consumption and longitudinal mental health outcomes

Study characteristics

One randomized controlled trial,[38] one non-randomized controlled trial,[16] and two prospective cohort studies[63,64] examined associations between breakfast consumption and longitudinal mental health outcomes.

The samples were conducted in the United Kingdom,[16] China,[64] Korea,[38] and Japan.[63]

The trials had small analytic samples of 105[38] and 213[16] participants. The prospective cohort studies had large analytic samples, because they consisted of a birth cohort (7,794 participants[63]) and population-based cohort (115,217 participants[64]).

Participant characteristics

The age or grade of participants across the observation period, and participant breakfast habit (when reported), are described for each study below. Other participant characteristics are described when they were part of the sampling strategy (e.g., birth cohort, population-based cohort). Participants were:

Participants were:

- A birth cohort consisting of all the children born from April 1989 to April 1990 in Toyama Prefecture, Japan who were observed from age nine to 12 years,[63]
- A population-based cohort of all districts in Hong Kong, who were observed from grade Primary 6 (P6, equivalent to U.S. grade 6) to grade Secondary 6 (S6, equivalent to U.S. grade 12),[64]
- Eight-year-old children who were followed for a 14-day period,[16] and
- Twelve- to 18-year-olds with an habitual breakfast frequency of fewer than three days per week who were followed for 12 weeks.[38]

Interventions/exposures

Randomized controlled trial

Kim et al.[38] allocated participants to a rice-based or wheat-based breakfast condition for 12 weeks. The breakfast conditions provided 761 kcal, 96-113g carbohydrates, 27-32g protein, and 20-31g fats. Participants in each of the breakfast conditions were compared to participants in a control group, who continued their usual habit of consuming breakfast fewer than 3 times per week.

Non-randomized controlled trial

Participants in the study by Smith[16] self-selected one of three breakfast groups based on their preference for Cornflakes, Rice Krispies, or Rice Krispies Multigrain. The breakfast cereal conditions were not standardized; children ate their selected cereal, plus milk and sugar to taste, *ad libitum*, each day for 14 days. Participants in each of the breakfast conditions were compared to participants in a control group, who continued their usual habit of not eating breakfast.

Prospective cohort studies

Chen et al.[63] examined self-reported breakfast frequency in two ways. One set of analyses examined breakfast frequency at a mean age of 9.7 years. Participants who reported eating breakfast *often*, *sometimes*, and *almost never*, were compared with participants who reported eating breakfast *every day*. The second set of analyses examined breakfast frequency patterns across time from a mean age of 9.7 years to a mean age of 12.8 years. Participants who reported increasing their breakfast frequency (from *sometimes* or *almost never* to *often* or *every day*), participants who reported decreasing their breakfast frequency (from *often* or *every day* to *sometimes* or *almost never*), and participants who reported eating breakfast sometimes or almost never across both time points, were compared to participants who reported eating breakfast often or every day across both time points.

Gong et al.[64] examined self-reported breakfast habits in grades P6, S2, and S4 (equivalent to U.S. grades 6, 8, and 10). Participants reported whether they ate no breakfast, breakfast at home, or breakfast away from home. Eating breakfast away from home included eating breakfast at a fast-food stall, cafeteria, restaurant, or “some other place”. Breakfast away from home did not include breakfast eaten as part of a school breakfast program, because the study authors state there is a “lack of such programs in Hong Kong”.

Outcomes and results

The results described here are presented in **Table 26** and synthesized in the discussion section Evidence synthesis: Breakfast consumption and longitudinal mental health outcomes.

- Chen et al.[63] assessed quality of life using the Japanese version of the Dartmouth Primary Care Cooperative Project Quality of Life Chart,[a] which asked participants, *“how have things been going for you during the past 4 weeks?”* Participants who responded, *“good and bad parts about equal”*, *“pretty bad”*, and *“very bad”* were classified as having a *“poor quality of life”* and participants who responded *“very well”* and *“pretty good”* were classified as having a *“good quality of life”.* The study authors assessed the odds of having poor (as opposed to good) quality of life at a mean age of 12.8 years.

  Skipping breakfast at age nine years (eating breakfast *almost never* or *sometimes* or *often* in comparison to *every day*), was not significantly associated with the odds of poor quality of life at age 12 years. On the other hand, an increase in breakfast frequency from nine to 12 years (from *sometimes* or *almost never* at nine years to *often* or *every day* at 12 years) was associated with significantly lower odds of poor quality of life at 12 years, and a decrease in breakfast frequency (from *often* or *every day* at nine years to *sometimes* or *almost never* at 12 years) was associated with significantly higher odds of poor quality of life.

- Gong et al.[64] assessed total emotional/behavioral problems in grades S2, S4, and S6 (equivalent to U.S. grades 8, 10, and 12) using the Youth Self-Report instrument.[b] The study also assessed the eight instrument subscales: withdrawal, somatic complaints, anxiety/depression, social problems, thought problems, attention problems, delinquent behaviors, and aggressive behaviors.

  Skipping breakfast in grades P6, S2, and S4 was associated with higher odds of total emotional/behavioral problems in grades S2, S4, and S6 when compared with eating breakfast at home and away from home. When compared to eating breakfast at home, skipping breakfast was associated with significantly higher odds of all eight subscales. However, when compared with eating breakfast away from home, skipping breakfast was associated with significantly higher odds of somatic complaints, thought problems, and aggressive behaviors, only.

- Kim et al.[38] assessed change in perceived stress from baseline to the 12-week follow-up using a Korean adaptation of the Perceived Stress Scale.[c] Perceived stress increased significantly in

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[a] Westbury RC, Rogers TB, Briggs TE, Allison DJ, Gérvas J, Shigemoto H, Elford W. A multinational study of the factorial structure and other characteristics of the Dartmouth COOP Functional Health Assessment Charts/WONCA. *Family practice.* 1997;14(6):478-485. https://doi.org/ 0.1093/fampra/14.6.478

[b] Achenbach TM, Rescorla LA. *Manual for the ASEBA School-Age Forms & Profiles*. Burlington, VT: University of Vermont, Research Center for Children, Youth, and Families; 2001.

[c] Park JH, Seo YS. Validation of the perceived stress scale (PSS) on samples of Korean university students. *Korean J. Psychol. Gen.* 2010; 29(3):611–629.

participants allocated to the wheat-based breakfast condition in comparison to participants allocated to the "usual intake" group (who continued to eat breakfast fewer than three days per week). Change in perceived stress did not differ between participants allocated to the rice-based breakfast condition and the "usual intake" group.

- Smith[16] measured parent-reported mood outcomes at day seven and 14 of the study. The outcomes were alertness before and after breakfast (authors did not specify how alertness before and after breakfast were measured in the group of children who did not eat breakfast but, based on the analysis, parents rated alertness at two time points), emotional distress, depression, fatigue, and negative mood. The authors used visual analog scales with the anchoring points "drowsy" on the far left and "alert" on the far right to measure alertness; Profile of Fatigue-Related Symptoms questionnaire[a] to measure emotional distress and fatigue; Hospital Anxiety and Depression Scale[b] to measure depression; and Mood questionnaire[c] to measure negative mood.

  Alertness before and after breakfast was significantly higher while emotional distress, depression, fatigue, and negative mood were significantly lower, at days seven and 14 in the children who ate no breakfast than in the children in the three ready-to-eat cereal groups.

[a] Ray C, Weir WR, Phillips S, Cullen S. Development of a measure of symptoms in chronic fatigue syndrome: the profile of fatigue-related symptoms (PFRS). *Psychology and Health.* 1992;7(1):27-43.

[b] Zigmond AS, Snaith RP. The hospital anxiety and depression scale. *Acta psychiatrica scandinavica.* 1983;67(6):361-370.

[c] Zevon MA, Tellegen A. The structure of mood change: An idiographic/nomothetic analysis. *Journal of Personality and Social Psychology.* 1982;43(1):111.

Key Question 2: What best practices exist in the U.S. School Breakfast Program, including models of student costs and breakfast delivery?

This rapid review includes evidence from 11 trials (13 articles) which inform summary statements:

- Three cluster-RCTs (five articles)[65-69]
- Eight NRCTs[70-77]

Several trials are represented by more than one article:

- One Healthy Breakfast Initiative (n=2 studies)[65,68]
- Project BreakFAST (n=2 studies)[66,67]

Evidence from 9 observational studies (11 articles) provided context and informed research recommendations.

- Six cross-sectional studies (7 articles).[78-84] Two cross-sectional studies shared the same data set.[79,80]
- Three pre-post studies without a control (4 articles).[85-88]

To facilitate meaningful synthesis and conclusion development, this body of evidence is presented by student cost model, delivery method and outcome category. Universal Free Breakfast (UFB) is the student cost model reviewed, and breakfast delivery methods reviewed include Breakfast in the Classroom (BIC), grab-and-go breakfast, second chance breakfast (SCB), and combinations of these models. Breakfast after the Bell (BAB) may include any model served after the start of the school day e.g., BIC, SCB or a grab-and-go meal. Traditional SBP is the breakfast meal served before school in the cafeteria with eligibility pricing. In this review, traditional SBP is commonly the comparator; however, some studies used UFB served in the cafeteria as the comparator. Details on SBP models are available at https://www.fns.usda.gov/sbp/school-breakfast-program.

Description of the evidence - Student cost model

Study characteristics

One cluster-RCT and four NRCTs examined the effect of UFB compared to traditional eligibility-based breakfast pricing in elementary schools,[69,75] elementary and middle schools,[74] and in elementary, middle, and high schools.[71,77]

The trials included a representative U.S. sample,[69] a Texas state-wide sample,[77] data from Wisconsin schools[71] (excluding those in Milwaukee), and schools located in urban areas in North Carolina,[75] and in New York City.[74] Trials range in size from 10 schools[75] to 2,797 schools.[77]

Participant characteristics

The five studies were conducted in elementary, middle, and high schools with racial and ethnic diversity and high proportions (between 54 and 84 percent) of students eligible for free or reduced-price (FRP) meals.

- Crepinsek et al.[69] reported data from the SBP Pilot Project, a cluster-RCT with 4,278 students from 153 elementary schools within 6 geographically and economically diverse school districts across the country. Fifty-four percent of students were eligible for FRP meals and 38 percent of students were non-white.
- Bartfeld et al.[71] used data from 1,007 Wisconsin elementary schools. Approximately 80 percent of students were white and approximately 31 percent were likely-eligible for FRP meals. Student-level

data on SBP participation were not used, but "likely-SBP eligible students" were identified using state administrative data. "Likely-SBP eligible students" were from low-income families (income less than 185% of the poverty line) that received Supplemental Nutrition Assistance Program (SNAP) benefits at some point during the previous 3 years. Higher-income students were those with a family income greater than 185 percent of the poverty line and not deemed categorically eligible for FRP meals. Sub-analyses were conducted for these subgroups.

- Schneider et al.[77] evaluated data from 2,797 elementary, middle, and high schools across the state of Texas that were ever Community Eligibility Provision (CEP) eligible and ever opted in during a 6-year period. Sixty-eight and 13 percent of students were Hispanic and black, respectively. Eighty percent of students were FRP meal eligible.
- Leos-Urbel et al.[74] included 773,843 students from 667 elementary and middle schools in New York City. Thirty eight percent were Hispanic and 33 percent black. Results were stratified by eligibility status. Approximately 84 percent were eligible for FRP meals.
- Ribar et al. [75] included ten elementary schools (8,078 students) from one North Carolina school district. Between 46 and 69 percent of students were black and between 12 and 24 percent of students were Hispanic. Results were reported for all students and stratified by eligibility status. Eligibility for free meals ranged from 56 to 81 percent, eligibility for reduced priced meals ranged from 7 to 14 percent.

Interventions

Included studies examined UFB compared to the traditional SBP with eligibility-pricing over a one-year[69,74,75,77] or five-year[71] period. In traditional SBP, free breakfast is restricted to students with a household income less than 185 percent of the federal poverty level. Data on student cost models were provided via administrative records.

- Crepinsek et al.[69] randomly assigned schools to receive UFB or to continue SBP with eligibility pricing for one year. Eighteen of the 79 intervention schools implemented UFB using the BIC delivery model.
- Three NRCTs used difference-in-difference analyses to evaluate policies impacting SBP pricing.
    - Schneider et al. 2021[77] examined outcomes in schools that opted into CEP (offered UFB), versus schools that did not opt into CEP (used eligibility-based pricing). Schools in the highest poverty areas may opt into the Community Eligibility Provision (CEP) to offer free meals to all students and to simplify administrative requirements.
    - Leos-Urbel et al. 2013[74] compared schools adopting UFB due to a New York City policy change, with schools that experienced no price change (e.g., schools that had UFB pricing before and after the new policy). In 2003, New York City made free breakfast available to all students, regardless of household income. Analysis is based on student, school, and meal data from 2001-2002 to 2007-2008.
    - A North Carolina school district examined UFB compared to eligibility pricing during a period when UFB availability was reduced in schools, due to budgetary constraints.[75]
- One NRCT, Bartfeld et al.[71] examined 5-year data (2009-2010 through 2013-2014) from schools that reported availability of UFB versus eligibility-pricing in the cafeteria. Results reflect availability of UFB at a school, not student participation in the SBP.

Outcomes and results

Studies examined the effect of UFB compared to eligibility pricing on SBP participation, diet quality, breakfast skipping, school performance (attendance and low attendance) and learning achievement. The results described here are presented in **Table 30** and synthesized in the discussion section Evidence syntheses: Student cost models

SBP participation

One RCT[69] and three NRCT[74,75,77] found UFB compared to eligibility-based pricing significantly increased SBP participation in elementary, middle, and high schools over a one-year period. SBP participation was assessed by studies via administrative records.[69,74,75,77] The RCT,[69] reported the increase in SBP participation among UFB elementary schools (from 16% to 40%) was 18 percentage points more than among control schools (from 16% to 22%) over a one-year period. Leos-Urbel et al.[74] found implementation of UFB compared to a balanced panel of schools (K-12) that experienced no pricing change (because they were already implementing UFB) increased SBP participation among all FRP meal categories, with the largest increase in the subsample of students eligible for full-price meals and smaller increases in students eligible for free and reduced-priced meals. In contrast, Ribar and Haliman,[75] evaluated outcomes during a period when numerous UFB schools returned to eligibility-based pricing due to budget constraints. UFB schools that returned to eligibility-based pricing and one school that switched from eligibility-pricing to UFB were compared to matched schools (by size, demographic, and economic characteristics) that did not have a change in SBP pricing. Access to UFB was associated with higher rates of SBP participation compared to the eligibility-based pricing model in the full sample as well as across FRP meal categories. Finally, Schneider et al.[77] used state-wide Texas data to evaluate the impact of opting into CEP on SBP participation and found opting into CEP significantly increased SBP participation by 3.44 percentage points during a one-year period.

Diet quality and breakfast skipping outcomes

The RCT[69] evaluated the effect of UFB compared to eligibility-pricing on diet quality and breakfast skipping. Breakfast intake was assessed via 24-hour dietary recall from a student and parent interview conducted after breakfast was served near the end of the first year of UFB implementation. Any breakfast consumption was defined as intake of any food or beverage (other than plain water) on the target school day. The authors noted that breakfast skipping was rare in the sample (4%), and they found no significant difference between intervention and control schools in terms of rate of any breakfast consumption. UFB schools reported significantly higher rates of nutritionally substantive breakfast consumption (80% vs 76%). Nutritionally substantive breakfast was defined as consumption of food from at least 2 of 5 food groups and intake of food energy greater than 10% of the 1989 Recommended Energy Allowance on the target school day.

School performance and learning achievement

Three NRCTs examined student meal costs and attendance, and results were inconsistent and learning achievement results primarily null. Leos-Urbel et al.[74] using difference-in-difference analysis in 667 high-poverty New York City schools found UFB implementation had no significant effect on attendance rates among all third through eighth graders, and in subgroups of students eligible and not eligible for free meals. Sub-analyses found two positive findings among higher income Asian and low-income black students, but analyses were not controlled for multiple comparisons. In a study conducted in 10 high-poverty North Carolina schools, Ribar and Haliman,[75] examined attendance in schools switching from UFB to eligibility pricing using student-level data and found UFB was significantly associated with marginally lower (-0.5 percentage point) attendance rates in elementary school students (equivalent to almost a full day per school year), and among economically disadvantaged students. In contrast, among a predominately white population of elementary school children with approximately 31 percent students likely-eligible for FRP meals, Bartfeld et al.[71] found availability of UFB associated with a 0.24 percentage-point higher annual attendance rate ($p<0.05$). In likely-SBP participants, availability of UFB was not significantly associated with attendance; however, among higher-income students, UFB was associated with a 0.31 percent increase in annual attendance rate. Bartfeld et al.[71] also assessed low attendance defined as the probability of attending less than 95% of annual school days. In the overall sample, Bartfeld et al.[71] found UFB had a 3.5 percentage-point reduction in the percentage of students with low attendance (P < 0.001)). Among likely-SBP participants, low attendance was significantly reduced by 3.3 percentage points (P < 0.001) and among higher-income students, a 3.5 percent reduction in the percentage of students with low attendance (P < 0.001) was found.

Three NRCTs examined the effect of UFB on standardized reading and math scores[65,74,75] and on science proficiency scores[75] assessed via administrative records. Two studies evaluated results from a 1-year period of implementation, and one study evaluated five-year data[71]; results in full samples were null. Student cost model was not associated with math and reading standardized test scores in third through eighth grade students from New York City who were and who were not eligible for free meals.[74] In a North Carolina sample, student SBP cost was not associated with math and reading test scores in third to fifth graders. On the other hand, UFB pricing was associated with higher science proficiency test scores in economically disadvantaged fifth graders (approximately seven percentage point increase) (p<0.05) but not among non-disadvantaged students.[75] Among third through fifth graders, Bartfeld et al.[71] found UFB compared to eligibility pricing had no significant effect on reading and math standardized test scores in all and in likely-SBP participants over a five-year period; however, scores were significantly greater in math (0.07 SD, p=0.001) and reading (0.04 SD, p=0.045) among high-income students.

Description of the evidence – Breakfast delivery models

Study characteristics - Breakfast in the classroom model

One cluster-RCT[65,68] and four NRCTs[70-73] examined the BIC delivery model.

- The cluster-RCT was conducted in eight matched pairs of elementary and middle schools from low-income urban communities in Philadelphia.
- Four NRCTs were conducted in U.S. urban school districts located in New York City,[72] in the southwest[73] and in the northeast[70] and in Wisconsin schools located outside Milwaukee.[71]

Study characteristics - Other breakfast after the bell delivery models

One cluster-RCT (two articles)[66,67] and one NRCT[76] examined the effect of other BAB delivery models compared to traditional SBP.

- The cluster-RCT reported on Project BreakFAST and was conducted in 16 rural high schools in Minnesota and examined the effect of a grab-and-go, SCB intervention added to the traditional SBP.[67]
- The NRCT[76] is a natural experiment which used 3-years of state-wide data from Colorado and Nevada schools to explore the effect of state-wide policy mandates to implement BAB in elementary, middle, and high schools with 70 percent or more students qualifying for FRP meals.

Participant Characteristics - Breakfast in the classroom model

Most studies were conducted in elementary and middle schools primarily located in racially and ethnically diverse, low-income communities (over 78 percent of students were FRP meal eligible). One study included elementary, middle, and high schools located in predominately white and higher income schools.

- The RCT[65,68] was conducted in 1,362 fourth through sixth graders from 16 urban, high-poverty schools of whom 66 percent and 17 percent were black and Hispanic, respectively.

- Two NRCTs[70,73] were conducted in high-poverty, majority Hispanic/Latinx populations (64-73 percent).
    - Anzman-Frasca et al.[70] included kindergarten through 6th grade students from 446 schools.
    - Imberman et al.[73] examined attendance and grades in students in first through fifth grades from 87 schools. Math and reading achievement were examined in 5th graders from 84 schools and sub-analyses were conducted to examine achievement scores by sex, race, ethnicity, prior academic achievement, English proficiency, and BMI category.
- Corcoran et al.[72] included 1,088 elementary and middle schools and analyzed data by degree of implementation. Schools that fully implemented BIC versus those that never implemented BIC had a greater percentage of students eligible for FRP meals (81 versus 67 percent), higher proportions of black and Hispanic students, lower average reading (-0.28 SD) and math (-0.31 SD) standardized test scores, and higher BMI.
- Bartfeld et al.[71] examined 5-year data from schools that reported availability of BIC (UFB or eligibility pricing) versus traditional SBP. Note, results reflect availability of BIC at a school, not student participation in the BIC, since student level information was not utilized.

Participant characteristics - Other breakfast after the bell delivery models

- The cluster-RCT[67] included predominately white, economically advantaged high school students from 16 high schools with low SBP participation (13 percent at baseline). Approximately 88 percent (median) of students were non-Hispanic white and approximately 32 percent were eligible for FRP meals. Hearst et al.[66] evaluated a subset of study participants (n=636) who reported eating breakfast less than or equal to three days per week. Students were classified as “traditionally low resource” (n=141) or “high resource” (n=495) using latent class analysis based on five sociodemographic measures (i.e., race, FRP meal status, household receives public assistance, food insecure, and school-level percent of students eligible for FRP meals). Results were reported for all habitual breakfast skippers and for low- or high-resource groups.
- Kirksey and Gottfried,[76] included 1,883 schools with close to 70 percent students eligible for FRP meals. Participants were 35 percent Latins, 5 percent black, and 3 percent Asian; and 48 percent of students qualified for FRP meals. Baseline chronic absenteeism was approximately 22 percent overall, and 15, 19 and 29 percent in elementary, middle, and high schools, respectively.

Interventions - Breakfast in the classroom model

One RCT and four NRCTs compared UFB-BIC to UFB in the cafeteria[65,68,72,73] or compared universal free-BIC[70] or BIC[71] to traditional SBP in the cafeteria.[70,71] Intervention duration ranged from 11 weeks[73] to 5 years.[71,72]

- In the RCT,[65,68] schools were randomized to receive universal free-BIC with breakfast-specific nutrition education (18, 45-minute lessons), a social marketing campaign, (e.g. posters for classrooms and cafeteria), corner store marketing of healthy choices (e.g. 1-2 shelf talkers with message or logo at stores within 0.5 miles of school), and parent outreach (e.g. monthly newsletters) or to received UFB served in the cafeteria and existing Supplemental Nutrition Assistance Program nutrition education. The duration of the intervention was 2.5 years.
- Four NRCT were natural experiments.[70-73]
    - Anzman-Frasca et al.[70] compared outcomes in 257 schools (57.6%) that implemented UFB-BIC with those from 189 schools that did not implement BIC and used eligibility pricing in the

cafeteria during the 2012-2013 school year. Data on SBP model was derived from administrative records. Propensity score weights were used to adjust for baseline differences between groups, and an intent-to-treat analysis was used.

- Bartfeld et al.[71] examined data from a 5-year period (2009-2010 through 2013-2014) in schools that reported availability of BIC versus eligibility pricing in the cafeteria. Results reflect availability of BIC, not student participation.

- Two NRCTs employed a difference-in-difference design and intent-to-treat analysis to evaluated universal free-BIC with UFB in the cafeteria. Data on model type was derived from administrative records.

  - Corcoran et al.[72] evaluated staggered implementation of UFB-BIC over a five-year period, and analyses were stratified by intensity or level of BIC coverage (low: <25%; moderate: >25% and <100%; full: 100% of classrooms).

  - Imberman et al.[73] examined the short-term effect of moving UFB from the cafeteria to the classroom during the first 11 weeks of implementation.

Interventions - Other breakfast after the bell delivery models

Two studies evaluated BAB models. The Project BreakFAST intervention[66,67] augmented breakfast in the cafeteria by offering grab-and-go carts for SCB outside the cafeteria; permitted students to eat in the hallway and some classrooms; was supported by a School Breakfast Expansion Team of stakeholders; provided funding ($4000/school) for a marketing firm to support development of a student-led marketing campaign; and provided implementation training with booster webinars for foodservice directors and one other staff member per school. Schools could tailor how they expanded SBP, some offered grab-and-go meals before and after the school day started, others just offered it after the start of the school day. The control schools received traditional SBP and eligibility pricing was used in both the intervention and control schools.

Kirksey and Gottfried[76] used sharp and fuzzy regression discontinuity designs to explore the effect of a sudden state-wide policy mandate to implement BAB in 1,883 schools with 70 percent or more students qualifying for FRP meals during the 2014-2015 school year. BAB interventions include both BIC and grab-and-go SCB interventions. BAB data were provided for Colorado schools from operational reports which described SBP model type (e.g., cafeteria, BAB, BIC, grab n' go) and for Nevada, schools reported whether they intended to implement BAB in the 2015-2016 school year in grant applications completed by the vast number of schools required to adopt BAB.

Outcomes and results - Breakfast in the classroom model

Studies examined the effect of BIC on SBP participation, breakfast skipping, diet quality, attendance, academic achievement, and weight-related outcomes. The results described here are presented in **Table 31** and synthesized in the discussion section Evidence syntheses: Breakfast delivery models.

SBP participation

SBP participation was assessed in three NRCTs using administrative records[70,72] or reported by teachers in the intervention schools or food service staff in the control schools.[68]

- Polonsky et al.[68] reported that SBP participation was significantly higher in intervention schools serving UFB in the classroom than in control schools serving UFB in the cafeteria (72% vs 25.9% at 1.5 years and 53.8 vs 24.9% at 2.5 years).

- Two large NRCTs conducted in elementary and middle schools[72] and in elementary schools[70] reported that universal free-BIC resulted in substantial increases in SBP participation in comparison to both traditional SBP[70] and UFB served in the cafeteria.[72]
    - Over a five-year period, Corcoran et al.[72] found significant increases in SBP participation in schools offering BIC, with the rate of participation increasing with increasing levels of BIC implementation within the school. The largest increase (30.2 percentage points) was in schools with implementation of BIC in all classrooms.
    - Anzman-Frasca et al.[70] found that universal free-BIC compared with traditional SBP was associated with significantly higher rates of SBP participation (73.7% vs 42.9%) in kindergarten through sixth grade students during the first year of implementation.

Breakfast skipping

Breakfast skipping was assessed in one RCT using the Breakfast Patterns Survey, designed to collect food and drink consumption among ethnically diverse low-income school-aged children (validity not reported).[65] Students completed the survey on one morning at baseline, 1.5 and 2.5 years. Skipped breakfast was counted if the student reported no intake of foods or beverages other than water. Bauer et al.[65] reported significantly lower odds of skipping breakfast in schools offering universal free-BIC compared to schools serving UFB in the cafeteria at 1.5 years, but the effect did not persist to 2.5 years.

Diet quality

Bauer et al.[65] assessed diet quality using the Breakfast Patterns Survey which included a 24-hour recall. The food consumption pattern assessment was based on USDA's meal component requirements: whether students consumed one of the following: 1 fruit or vegetable, 1 grain, and 1 milk; 1 fruit or vegetable and 2 grains; or 1 fruit or vegetable,1 grain, and 1 meat or meat alternative. Bouer et al. reported significantly higher odds of consuming a food pattern meeting the USDA nutritional requirements among students from intervention schools (universal free-BIC) than among control schools (UFB in the cafeteria) at 1.5 and 2.5 years.

Attendance and learning achievement

Four studies assessed attendance[70-73] one also assessed high attendance (the percentage of students who attend greater than or equal to 96% of enrolled school days)[70] and one also assessed low attendance (the probability of attending less than 95% of annual school days)[71] using administrative data.

- Three of four NRCTs[71-73] found BIC[71] or universal free-BIC[72,73] compared to traditional SBP[71] or UFB in the cafeteria[72,73] had no effect on attendance in the full sample. Imberman and Kugker[73] analyzed results by grade and prior year achievement and found no significant effect.
- One NRCT[70] found universal free-BIC compared to traditional SBP had a small but significant beneficial effect on attendance, and high attendance in high-poverty, urban elementary schools.

Four NRCTs[70-73] reported BIC had no significant effect on student standardized math and reading test scores in the full sample of students. Test scores were provided from administrative records. Imberman and Kugker[73] also evaluated mean grade across all courses at the 9-week point in implementation and found BIC had no effect.

- Anzman-Frasca et al.[70] found universal free-BIC compared to eligibility-priced breakfast in the cafeteria for one-year was associated with no significant differences in math or reading achievement in second through sixth graders.

- Corcoran et al.[72] found universal free-BIC had little effect, compared with UFB in the cafeteria, among elementary and middle school on changes in math and reading standardized test scores across most levels of BIC coverage. The only significant finding was a small increase in math test scores (0.007 SD increase) when using student-level, but not school-level data.
- Bartfeld et al.[71] found BIC had no significant effect on normalized math and reading test scores in third through fifth graders.
- Finally, Imberman and Kugker,[73] studied the impact of moving UFB from the cafeteria to the classroom during the first 11 weeks of BIC intervention and found no significant effect on mean course grade over a 9-week period in students in first through fifth grade. Also, among fifth grade students, BIC had no significant effect on math and reading standardized test scores. Imberman and Kugker,[73] further evaluated fifth grader achievement outcomes by sex, race, ethnicity, SES, academic achievement the previous year, English language proficiency, and weight status and found a significant association within some subgroups (e.g., an increase in math, and reading scores among Hispanic students); however, analyses were not controlled for multiple comparisons.

Weight-related outcomes

Weight-related outcomes were assessed in two studies.[68,72] Trained researchers[68] or school staff[72] measured height and weight using a standard protocol. BMI-z score values were used to assess weight status (i.e., overweight, obese) and change in BMI-z score.

- Among sixth through eighth graders, Polonsky et al.[68] reported that the incidence of obesity was significantly higher in schools serving universal free-BIC compared to UFB in the cafeteria at 1.5 years (7.1% vs 4.3%), and at 2.5 years (11.6% vs 4.4%). Prevalence of obesity was significantly higher in schools receiving BIC at 2.5 years (28.0% vs 21.2%), while the increase was not significant at 1.5 years (25.2% vs 23.6%). No significant difference was found between intervention and control schools in combined incidence of overweight and obesity, or in BMI z-score at 1.5 and at 2.5 years.
- Corcoran et al.[72] found the universal free-BIC delivery model compared to UFB in the cafeteria had no effect on BMI z-score and obesity across most levels of BIC implementation; however, they did find very small, significant increases in BMI z-score ($p<0.05$) and obesity ($p<0.05$) in elementary schools with low BIC coverage (less than 25 percent implementation) when using student-level data.

Outcomes and results: Other breakfast after the bell delivery models

Studies examined other BAB delivery methods and SBP participation, attendance and learning achievement. Results are presented in **Table 31** and synthesized in the discussion section Evidence syntheses: Breakfast delivery models.

SBP participation

Nanney et al.[67] evaluated change in school-level mean SBP participation rate via administrative records. The investigators found an environmental intervention that augmented breakfast in the cafeteria with grab-and-go, SCB, policy change, and marketing significantly increased median SBP participation by 3 percent in the intervention schools, while there was a 0.5 percent increase in the control group during the first year of implementation.

Attendance and learning achievement

Hearst et al.[66] in the same RCT, evaluated unweighted cumulative GPA in 12 high schools. Among all habitual breakfast skippers and in low-resource or high-resource groups, no significant difference was found between the intervention and control groups in unweighted GPA at one year.

Kirksey and Gottfried,[76] evaluated data on chronic absenteeism (defined as the percent of students missing greater than 15 days of the school year) derived from administrative records and change in school-level standardized reading and math test scores from Colorado and Nevada state's Department of Education. Investigators found schools with BAB compared to those without BAB significantly reduced chronic absenteeism. Effect on chronic absenteeism varied by school level. Reduction was 4 percent among all students, 3 percent in elementary, 3 percent in middle school and 7 percent in high school students. No significant effect was observed between BAB and standardized math or reading scores in Colorado or Nevada at any school level.

Kirksey and Gottfried, 2021[76] also evaluated school-level characteristics which may moderate the effect of BAB on chronic absenteeism, including: FRP and overall SBP participation; change in overall and in FRP eligible participation; Title 1 status; universal free meal status; urbanicity; lag in BAB implementation, achievement, or chronic absence; district effects; covariates. Among schools that offered BAB, a significantly greater decline in chronic absenteeism was observed in those that: offered UFB (-0.04 (0.01) $p<0.01$), increased overall SBP participation (−0.05 (SE=0.02), $p<0.05$), increased FRP meal eligible participation (−0.06 (SE=0.02), $p<0.05$), and were suburban (−0.02 (0.01), $p<0.05$).

Description of evidence - Observational studies

Six cross-sectional studies (7 articles)[78-84] and three pre-post studies without a control (4 articles)[85-88] evaluated SBP student cost and delivery models in a range of populations. Participant characteristics, exposures, comparators, outcomes and results are described in **Table 32** and discussed in context with trial findings below.

Student cost model

Two CS studies, one in a U.S representative sample[81] and the other in a statewide sample from North Carolina,[83] analyzed data from elementary, middle, and high schools with greater than 60 percent students eligible for FRP meals. Both studies found UFB increased SBP participation. Soldovini et al.[83] did not control for all key confounders and used multiple significance testing without correction. Leider et al.[81] assessed breakfast liking using a validated Child/Youth Interview survey and found a positive association between UFB and acceptance or liking of SBP.

Breakfast delivery models

Four CS studies and one UPP study compared BIC or universal free-BIC with traditional SBP in the cafeteria or UFB in the cafeteria in elementary schools[71,79,80,82,84,87] and elementary, middle, and high schools.[83] Results are consistent with findings from trials and indicate that BIC[71,79,80,82] and universal-free-BIC[84,87] compared with traditional SBP[78-80,82,83,87] or UFB in the cafeteria[84] are associated with increased SBP participation,[71,80,83,84,87] and improved diet quality.[82] Soldavini et al.[83] found eligibility-based BIC versus breakfast before school in the cafeteria increased SBP participation among elementary and high school students, and universal-free BIC versus traditional SBP increased SBP participation at all school levels. CS studies found BIC was associated with reduced breakfast skipping.[82,84,87] Baxter[79] examined BMI (calculated from measured heights and weights) and found BIC was associated with a higher BMI but not with BMI category (i.e., underweight, healthy weight, overweight, obese, severely obese). Ritchie et al.[82] reported BIC was significantly associated with more students eating breakfast both at home and at school.

Two CS studies[82,83] and one UPP study[87] examined outcomes associated with grab-and-go and/or SCB interventions and result were consistent with trial data for SBP participation and diet quality. Soldavini et al.[83] found serving breakfast for free to all student alone or in combination with BIC, grab-and-go breakfast or SCB increased SBP participation at all levels of schools in North Carolina. BIC plus grab-and-go was significantly associated with an increase in SBP participation in elementary and high school students and grab-and-go and SCB was significantly associated with improved SBP participation in middle and high school students. Moeltner et al.[87] found assembling students in the cafeteria and extending traditional SBP by 10 minutes past the bell significantly increased SBP participation in elementary school students. Ritchie et al.[82] found BIC versus SCB (i.e., breakfast served in the cafeteria before school and again at first recess) was significantly associated with improved student Health Eating Index 2010 score and SCB was not significantly association with breakfast skipping among fourth and fifth graders from California. Bartfeld et al.[71] found BIC and increasing the duration of the school breakfast period was associated with increased SBP participation but serving breakfast in common areas or other locations was not associated with significant change in SBP participation. CS studies are subject to serious risk of bias due to the inadequate adjustment for all key confounders[79,80,82,84] and the use of self-reported outcome data.[78,84] One study used multiple significance testing without correction[83] and the pre-post test had no control group.[87]

Three UPP studies provide additional context for Project BreakFAST RCT results.[85,86,88] Larson et al.[86] found grab-and-go and SCB increased SBP participation in all students, in habitual breakfast skippers, and in students eligible for FRP meals, students not eligible for FRP meals, Hispanic and white students. Grannon et al.[85] evaluated the effect of the grab-and-go and the SCB intervention components in 12 schools that were able to record the time of breakfast purchases. SBP participation was assessed at the school-level and among habitual breakfast skippers, and in both groups, SBP participation increased significantly from the time when traditional SBP was offered to the time when traditional SBP was augmented with grab-and-go SCB. During that transition, participation in traditional SBP decreased while grab-and-go SCB was responsible for 12.4% participation. Finally, a small pilot-study conducted in one middle school in the same school district years earlier found grab-and-go breakfast in the hallway (eligibility pricing) for 6-weeks was significantly associated with an increase in SBP participation in all students and in students eligible and not eligible for FRP meals.[88] UPP study results are interpreted with caution since the studies are subject to serious risks of bias because they lack a control group.

Discussion

Key Question 1a: What is the relationship between eating breakfast and school performance?

Evidence synthesis – Learning achievement

Four studies, including two RCTs,[1,2] one cohort,[3] and one cross-sectional study[4] assessed the association between breakfast consumption and learning achievement. The observational studies were well-conducted, and the cross-sectional study was nested within a cluster RCT. All studies showed that there was an association between breakfast consumption and at least one measure of learning achievement. However, due to a high degree of heterogeneity between studies in terms of study design and methodology, it was difficult to draw a stronger summary statement. Some of the notable issues in this body of evidence is discussed below –

- Despite randomization, there were baseline differences in math scores in both trials, with the fasting group scoring significantly higher on baseline test than the breakfast group.[1,2] It is possible that the baseline differences in these trials could have blurred the post-intervention differences between the intervention and control groups.
- Kawabata et al.[2] noted that the study may not have been sufficiently powered to assess the effect.
- While these trials[1,2] were conducted in a laboratory-based setting, which provided greater control for monitoring compliance, generalizability of the findings in a general setting is unclear.

Risk of bias for this body of evidence is presented in **Table 9** and **Table 10**.

Evidence synthesis – Cognitive development

With 12 RCTs,[2,5-15] one non-RCT,[16] one cohort study[17] and three cross-sectional studies,[18-20] there was a modest body of evidence available to examine the relationship between breakfast consumption and cognitive outcomes in children and adolescents. Most of these, except one cohort study,[17] assessed acute breakfast effects.

The studies that assessed cognitive development had notable limitations, irrespective of the study designs. However, these limitations may not necessarily explain all inconsistencies in findings. Risk of bias for this body of evidence is presented in **Table 12**, **Table 13**, and **Table 14**.

Randomized controlled trials

- Sample size: Some studies in this body of evidence had small sample sizes (e.g., 10,[11] 19,[8] 21,[10] 40,[2,7] 41[6] participants) and almost half of the trials [5,6,10,12,13,15] did not report power calculations. Further, Fulford et al.[8] and Kawabata et al.[2] acknowledged that their studies were underpowered to assess the impact on cognitive task performances.
- Blinding: None of the studies were able to blind participants to breakfast or no breakfast.[2,5-15] Kawabata et al.[2] reported that the researchers disclosed the allocation at the start of the morning, rather than waiting until the treatment began. It is unclear if this resulted in some differences but given that most measures in this study were objective, it is unlikely to have impacted the findings.
- Timing of outcome assessment: There were wide variations in the time of outcome assessment, which ranged from 60[12] to 245 minutes[14] post-breakfast. Studies assessed the cognitive outcomes at baseline

and had one follow-up,[7-9,11-13,15] whereas others had repeated follow-up measures[2,5,6,10,14] on the same day.

- Outcome:
  - In this review, studies used multiple tests or multiple aspects of the same test to assess cognitive outcomes. For example, Defeyter and Russo[7] measured complex attention using rapid visual information processing, choice reaction time, and serial subtraction. Mahoney et al.[12] reported four different measures (hits, miss rates, false alarm and reaction time to hits) for a single auditory attention test. While assessing a single domain using multiple tests allowed studies to ensure comprehensive assessment, there was also a high likelihood of finding spurious effects because of multiple testing. Further, none of the trials used Bonferroni correction for multiple testing except one trial,[9] which found no effect on any of its tests.
  - There was lack of consistency in study findings. It was rare to use the same tests across studies; even when they did so, studies did not report consistent findings. For example, Cooper et al. (2011)[5] showed that accuracy on the Stroop test was better maintained in breakfast consumers, but there was no effect on the response time. Similarly, Cooper et al. (2012)[6] showed that breakfast consumers were quicker and more accurate in Stroop test, but this was observed only in those in the low-GI breakfast group compared to no breakfast; this was not noted in the high-GI breakfast group. Defeyter & Russo[7] who also administered Stroop test, showed no difference in reaction time or percent correct in both easy and difficult versions.
  - Further, there was heterogeneity in the mode of administration, which included: 1) computerized testing;[2,6-8,10,14] and 2) pencil and paper testing.[9,12,13] The equivalence of computer- and paper-based testing has been shown to be reasonable for some tests in an older population, but is unknown for many tests that are administered in children.
- *A priori* hypothesis: Another notable challenge is that most studies did not provide *a priori* hypotheses or a rationale for choosing the test(s). Further, it is unclear whether the tests chosen were sensitive enough to dietary interventions and were capable of detecting small changes in performance. While these concerns are most relevant for RCTs, they are applicable for observational studies as well.
- Study setting: Study setting is an important consideration, with studies in laboratory settings offering greater control, but is being less reflective of real-life settings. On the other hand, in school-based studies, it is possible that the cognitive demand of class lessons administered during a waiting period could interfere with participant's performance. However, such information is not provided in most of the studies.

Non-randomized controlled trial and cross-sectional studies

- Sample size: Except Peña-Jorquera et al.[20] other studies[16-19] did not report power calculations. While this is less of an issue for studies with sufficient sample sizes, it is unclear if Benton and Jarvis[19] had the power to detect the differences given that they included only 20 participants.
- Confounders**:** Two cross-sectional studies[18,19] and the NRCT[16] did not adjust for important confounders such as SES, parent's education or family income in their analysis. Peña-Jorquera et al. adjusted for schools, since it is associated with socio-economic background, and other important characteristics.[20] Liu et al. adjusted for parental education and maternal occupations.[17] Since these studies are observational, residual and unmeasured confounding cannot be ruled out.
- Timing: The time window for administering cognitive test post-breakfast may be important to observe association with breakfast consumption. Yet, the exact time between breakfast consumption and

cognition assessment was not reported for any of the studies that assessed acute breakfast effects.[16,18-20]

- Exposure:
  - The only non-RCT study in this body of evidence,[16] enrolled habitual breakfast consumers and skippers and assigned them to the type of breakfast cereal, based on participant's preference. Although the study encouraged *ad libitum* breakfast (i.e., instructing participants to self-select and eat breakfast until comfortably full), the study did not report participant's fidelity to a particular cereal consumption. Further, children were allowed to add *ad libitum* milk and sugar, were not restricted to a specific time of eating the cereal, and were free to consume the amount they wanted.
  - Peña-Jorquera et al.[20] assessed breakfast intake based on a question from Mediterranean Diet Quality index. Two other cross-sectional studies[18,19] assessed breakfast consumption using a non-validated questionnaire that asked a few questions about breakfast intake, frequency, and portion size.
  - Liu et al.[17] collected habitual breakfast consumption by asking the parents about how often their children have breakfast. It is unclear if the questionnaire was validated.
- Outcome:
  - One cross-sectional study[18] used multiple tests to assess cognitive outcomes such as attention and memory, but did not appropriately adjust the p-values for multiple testing.
  - There was heterogeneity in how outcomes were assessed in cross-sectional studies. For example, two studies[18,20] used computerized testing to assess complex attention; whereas, one study assessed cognition by observing students' behavior.[19] However, it is not clear how comparable these measures are.
  - Liu et al.[17] assessed cognitive outcomes with Chinese version of the Wechsler Preschool and Primary Scale of Intelligence—Revised. Specifically, verbal IQ, performance IQ and full-scale IQ were measured. It is unclear if it was validated and how comparable this translated version is to other tools.
  - The NRCT assessed child's alertness and cognitive difficulties using parent's perception of children's behavior as opposed to a standardized cognitive test.[16] It is possible that parent's preconceived notions about the benefits of breakfast may have impacted their perception and how they assessed their child's performance on these tests.

Summary statement:

Eating breakfast may result in improved learning achievement later in the day in school-aged children. The evidence comes from four small well-conducted studies with marked heterogeneity. Additional studies are needed to assess acute and longitudinal effects of breakfast consumption in school-aged children.

The effect of eating breakfast, compared to fasting, on measures of cognitive development in school-aged children is unclear. Despite a reasonable number of studies, the ability to draw conclusions was restricted by inconsistency in study findings, heterogeneity in cognitive tests, and small sample sizes.

Research recommendations

- The RCTs in this body of evidence assessed acute breakfast effects. While the temporary effects of breakfast consumption are important, there is a need to conduct RCTs and well-designed longitudinal cohort studies with multiple time point measures to assess the sustained effects of habitual breakfast intake.
- Future research should include intervention/exposure that closely resemble participants' habitual breakfast consumption. Observational studies should use validated questionnaires to collect exposure data.
- Studies should articulate their aim and hypothesis *a priori* and choose appropriate cognitive tests that are sensitive to acute nutritional manipulations. Further, studies are needed to assess the effect of breakfast on other relevant outcomes such as observed classroom behavior.
- Many RCTs had small sample sizes and were probably underpowered to observe an effect. There is a need to conduct studies with larger sample sizes, derived on power calculations based on effect sizes and practical significant differences.
- Studies should include different population sub-groups (e.g., children of lower SES and racial/ethnic group minorities) to examine the relationship between breakfast consumption and learning achievement and cognitive outcomes. Further, studies should collect data on confounders such as SES and sex and should account for them in the analyses, especially in observational studies.
- To improve generalizability of study findings, more studies should be conducted in school-based settings, in addition to those that are conducted in a well-controlled laboratory setting.
- Studies that measure acute breakfast effects should aim to assess whether breakfast effects on the outcome are impacted by timing of assessment.

Rapid review conclusions in context of existing narrative review

Learning achievement

Overall, the conclusions from this rapid review that breakfast consumption may be associated with some measures of learning achievement is somewhat consistent with what Murphy[a] summarized. Murphy's conclusions are based on studies[b,c,d,e] published in developed and developing countries prior to 2005 exploring the relationship between breakfast consumption or skipping and learning achievement outcomes. Two studies, conducted in Malaysia[c] and Saudi Arabia[a], reported that breakfast skipping was more prevalent among students with poor performance. One study conducted in South Korea[d] noted that regular breakfast

[a] Murphy, JM. Breakfast and learning: an updated review. *Current Nutrition & Food Science.* 2007; 3(1):3-36. https://doi.org/10.2174/1573401310703010003.

[b]Abalkhail, B., & Shawky, S. (2002). Prevalence of daily breakfast intake, iron deficiency anaemia and awareness of being anaemic among Saudi school students. *Int J Food Sci Nutr, 53*(6), 519-528. https://doi.org/10.1080/09637480220164370

[c] Berkey, C. S., Rockett, H. R., Gillman, M. W., Field, A. E., & Colditz, G. A. (2003). Longitudinal study of skipping breakfast and weight change in adolescents. *Int J Obes Relat Metab Disord, 27*(10), 1258-1266. https://doi.org/10.1038/sj.ijo.0802402

[d] Boey, C. C., Omar, A., & Arul Phillips, J. (2003). Correlation among academic performance, recurrent abdominal pain and other factors in Year-6 urban primary-school children in Malaysia. *J Paediatr Child Health, 39*(5), 352-357. https://doi.org/ 10.1046/j.1440-1754.2003.00173.x

[e] Kim, H. Y., Frongillo, E. A., Han, S. S., Oh, S. Y., Kim, W. K., Jang, Y. A., . . . Kim, S. H. (2003). Academic performance of Korean children is associated with dietary behaviours and physical status. *Asia Pac J Clin Nutr, 12*(2), 186-192.

consumption was associated with higher GPA. In a study conducted in the U.S. (which Murphy[a] noted as being "somewhat more subjective(ly)") children who skipped breakfast at least once per week rated themselves as doing less well in school. The evidence on learning achievement in this rapid review comes from four studies conducted in school-aged children, which examined the association between acute breakfast or longitudinal intake of breakfast and academic performance using standardized tests.[1-4] Beyond school performance, Murphy[e] reported that breakfast consumption improved attendance and tardiness, based on city, state and non-U.S. school breakfast studies and school breakfast pilot project (SBPP); however, none of the studies in this rapid review measured attendance and tardiness outcomes.

Cognition

Based on studies until late 1990s, Murphy (citing the work of Pollitt and Mathews[b]) noted that "no definitive conclusions can be drawn from the existing data on either a) long- and b) short-term benefits of breakfast on cognition" or the underlying mechanisms. Murphy (Murphy, 2007) also noted that skipping breakfast interfered with cognition and learning based on one pilot study conducted by Jacoby et al.[c] in Peru in early 1990s. While Jacoby et al. did not find a breakfast effect on vocabulary scores, there was a significant interaction with weight suggesting an improved vocabulary performance among heavier children.

Murphy summarized studies on overall breakfast consumption and cognition published between 1999 and 2004 and reported potential beneficial breakfast effects on cognition[d, e, f, g, h]. Available studies were conducted in adult men and women[h,i,k] evaluating short-term breakfast interventions (i.e., a combination of breakfast/no breakfast and caffeinated/decaffeinated condition[i], high vs. low GI index meals[j], assessing glucose tolerance[k], cereal breakfast vs. no breakfast[l]). One cross-sectional study was described as the first study to report on the relationship between habitual breakfast and intellectual performance in a well-nourished population of school

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[a] Murphy, JM. Breakfast and learning: an updated review. *Current Nutrition & Food Science.* 2007; 3(1):3-36. https://doi.org/10.2174/1573401310703010003.

[b] Pollitt, E., & Mathews, R. (1998). Breakfast and cognition: an integrative summary. Am J Clin Nutr, 67(4), 804S-813S. https://doi.org/10.1093/ajcn/67.4.804S

[c] Jacoby, E. R., Cueto, S., & Pollitt, E. (1996). Benefits of a School Breakfast Programme among Andean Children in Huaraz, Peru. *Food and Nutrition Bulletin, 17*(1), 1-11. https://doi.org/10.1177/156482659601700111

[d] Benton, D., Ruffin, M. P., Lassel, T., Nabb, S., Messaoudi, M., Vinoy, S., . . . Lang, V. (2003). The delivery rate of dietary carbohydrates affects cognitive performance in both rats and humans. *Psychopharmacology (Berl), 166*(1), 86-90. https://doi.org/10.1007/s00213-002-1334-5.

[e] Donohoe, R. T., & Benton, D. (2000). Glucose tolerance predicts performance on tests of memory and cognition. *Physiol Behav, 71*(3-4), 395-401. https://doi.org/10.1016/s0031-9384(00)00359-0.

[f] Lopez-Sobaler, A. M., Ortega, R. M., Quintas, M. E., Navia, B., & Requejo, A. M. (2003). Relationship between habitual breakfast and intellectual performance (logical reasoning) in well-nourished schoolchildren of Madrid (Spain). Eur J Clin Nutr, 57 Suppl 1, S49-53. https://doi.org/10.1038/sj.ejcn.1601815.

[g] Smith, A. P., Clark, R., & Gallagher, J. (1999). Breakfast cereal and caffeinated coffee: effects on working memory, attention, mood, and cardiovascular function. *Physiol Behav, 67*(1), 9-17. https://doi.org/10.1016/s0031-9384(99)00025-6.

[h] Wesnes, K. A., Pincock, C., Richardson, D., Helm, G., & Hails, S. (2003). Breakfast reduces declines in attention and memory over the morning in schoolchildren. *Appetite, 41*(3), 329-331. https://doi.org/ 10.1016/j.appet.2003.08.009.

[i] Smith, A. P., Clark, R., & Gallagher, J. (1999). Breakfast cereal and caffeinated coffee: effects on working memory, attention, mood, and cardiovascular function. *Physiol Behav, 67*(1), 9-17. https://doi.org/ 10.1016/s0031-9384(99)00025-6.

[j] Benton, D., Ruffin, M. P., Lassel, T., Nabb, S., Messaoudi, M., Vinoy, S., . . . Lang, V. (2003). The delivery rate of dietary carbohydrates affects cognitive performance in both rats and humans. *Psychopharmacology (Berl), 166*(1), 86-90. https://doi.org/10.1007/s00213-002-1334-5.

[k] Donohoe, R. T., & Benton, D. (2000). Glucose tolerance predicts performance on tests of memory and cognition. *Physiol Behav, 71*(3-4), 395-401. https://doi.org/ 10.1016/s0031-9384(00)00359-0.

[l] Wesnes, K. A., Pincock, C., Richardson, D., Helm, G., & Hails, S. (2003). Breakfast reduces declines in attention and memory over the morning in schoolchildren. *Appetite, 41*(3), 329-331. https://doi.org/ 10.1016/j.appet.2003.08.009.

children[a]. Based on the above evidence, Murphy noted a positive association between breakfast and cognitive measures.

This rapid review was able to extend Murphy's finding in a few important ways. First, Murphy included a number of non-experimental studies in the review and noted that non-experimental study design could potentially introduce a selection bias. This review was able to address this limitation by including evidence that was mostly experimental. Further, all the studies included in this review were conducted in the U.S. or in similar high-income countries, and participants were school-aged children. Second, Murphy noted that no definitive conclusions can be drawn on the short-term benefits of a single breakfast on learning. Because most of the studies included in this review assessed short-term effects of breakfast, this rapid review filled this important gap. Murphy identified a number of methodological limitations such as non-experimental study designs, small sample sizes, limited attention to any one outcome and use of multiple significance testing without correction. While a few of these persist, especially in the cognition literature, this rapid review has been able to address many of them. In summary, this review was able to confirm some of Murphy's conclusions on school performance and cognition. There were some similarities in the evidence base, but there were also subtle differences. Readers are thus encouraged to keep in mind the uniqueness of each review (and its evidence base) when comparing, contrasting, and interpreting the findings.

[a] Lopez-Sobaler, A. M., Ortega, R. M., Quintas, M. E., Navia, B., & Requejo, A. M. (2003). Relationship between habitual breakfast and intellectual performance (logical reasoning) in well-nourished schoolchildren of Madrid (Spain). Eur J Clin Nutr, 57 Suppl 1, S49-53. https://doi.org/10.1038/sj.ejcn.1601815.

Table 8: Effects of breakfast consumption on learning achievement[a]

Study	Notable participant characteristics	Intervention and comparator	Outcomes	Results
Pivik et al. 2012[1] RCT (parallel) US	Analytic N: 81 Mean age: 9.8±0.8	Breakfast vs fasting condition	WRAT-3 Arithmetic subtest scores, baseline	**Fasting (108.2±10.3) higher than breakfast (101.6±12.7) (p=0.01)**
			Correct responses for fasting vs. breakfast group (estimated from figures) Between group differences	Before breakfast: 58 vs. 53; post-breakfast/fasting: 61 vs. 57, P > 0.05
			Correct responses for fasting vs. breakfast group (estimated from figures) Within group differences	**Breakfast: Significantly greater increases (53 to 57) from before and after breakfast, P < 0.001** Fasting: No significant changes (58 to 61) from before and after the breakfast treatment, P > 0.05
			Response time for fasting vs. breakfast group (estimated from figures) Between group differences (ms)	Before breakfast: 960 vs. 890; post-breakfast/fasting: 940 vs. 910, P > 0.05
			Response time for fasting vs. breakfast group (estimated from figures) Within group differences	**Breakfast: Significant decrease in response time (960 vs. 940 ms) from before and after the breakfast treatment, P < 0.05** Fasting: No significant differences in response time (890 vs. 910 ms) from before and after breakfast, P > 0.05
Kawabata et al. 2021[2] RCT (parallel) Singapore	Analytic N: 40 Mean age 16y Majority female (78%) Normal BMI	Breakfast condition vs fasting condition (both conditions include 30 min of exercise at -30min)	Math test scores at -30 min	**Fasting higher than breakfast (p=0.04)**
			Math test score from -30 to ~+180 min	β=-2.81, p=0.08
			Computational time (math speed) at -30 min	NS (data NR); p>0.05

			Computational time from -30 min to ~+180 min	**β=-0.057, p=0.04**
			Oral word fluency (i.e. total number of valid words retrieved or speed of word retrieval) at -30 min and change over the study duration	NS (data NR); p>0.05
Littlecott et al. 2016[3] Prospective Cohort Study UK	Analytic N:1216 Mean range: 9-11 y School lunch eligibility (based on low-income status): 21.6%	Exposure: Breakfast consumed during 2 assessment days Comparator: Breakfast consumed for less than 2 days during assessment	Educational outcomes: Breakfast consumed 16-18 mo prior	**OR: 1.61 (95% CI: 1.24, 2.47)**
			Educational outcomes: Breakfast consumed 4-6 mo prior	**OR: 2.02 (95% CI: 1.44, 2.84)**
Ptomey, 2016[4] Cross-sectional US	Analytic N:162 Mean age: 7.5 ± 0.6 y	Exposure: Breakfast consumed, the morning of assessment Comparator: No breakfast	WIAT-III Mathematics standard score	**Breakfast: 103.25±12.86, No breakfast: 98.19±8.95, P = 0.007**
			WIAT III Spelling standard score	**Breakfast: 100.49±12.73 vs. No breakfast: 95.85±10.27, P < 0.05**
			WIAT III Reading comprehension and fluency standard score	**Breakfast: 100.05±14.25 vs. No breakfast: 95.16 ± 12.93, P < 0.05**

[a] Abbreviations: WRAT Wide Range Achievement Test, WIAT Wechsler Individual Achievement Test

RCT: randomized controlled trial; UK: United Kingdom; US: United States; y: years

Table 9: Risk of bias for the randomized controlled trial examining the effects of breakfast consumption on learning achievement[a]

Article	Randomization	Period and carryover effects	Deviations from intended interventions	Missing outcome data	Outcome measurement	Selection of the reported result
Kawabata et al. 2021[2] Parallel RCT	**SOME CONCERNS** Baseline differences between groups may relate to randomization or outcome measurement	**N/A**	**LOW**	**LOW**	**LOW**	**SOME CONCERNS** No registered protocol reported
Pivik et al. 2012[1] Parallel RCT	**SOME CONCERNS** Baseline differences in arithmetic scores	**N/A**	**LOW**	**LOW**	**LOW**	**SOME CONCERNS** No registered protocol reported

Table 10: Risk of bias for the observational studies examining the association between breakfast consumption and learning achievement[b]

Article	**Confounding** (Key confounders: age, sex, SES, race/ethnicity, physical activity)	Selection of participants	Classification of exposures	Deviations from intended exposures	Missing data	Outcome measurement	Selection of the reported result
Littlecott et al. 2016[3]	**MODERATE** Not adjusted for age, race/ethnicity, BMI	**LOW**	**MODERATE** Exposures measured in two intances spread across in time	**MODERATE** Number of participants that had the exposure changed from baseline to f/u	**LOW**	**LOW**	**MODERATE** No-pre-registered protocol
Ptomey et al. 2016[4]	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**MODERATE** No-pre-registered protocol

[a] Possible ratings of low, some concerns, or high determined using the "Cochrane Risk-of-bias 2.0" (RoB 2.0) (August 2016 version)" (Higgins JPT, Sterne JAC, Savović J, Page MJ, Hróbjartsson A, Boutron I, Reeves B, Eldridge S. A revised tool for assessing risk of bias in randomized trials In: Chandler J, McKenzie J, Boutron I, Welch V (editors). Cochrane Methods. *Cochrane Database of Systematic Reviews* 2016, Issue 10 (Suppl 1). https://doi.org/10.1002/14651858.CD201601.)

[b] Possible ratings of low, moderate, serious, critical, or no information determined using the "Risk of Bias for Nutrition Observational Studies" tool (RoB-NObs) (Dietary Guidelines Advisory Committee. 2020. *Scientific Report of the 2020 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Agriculture and the Secretary of Health and Human Services*. U.S. Department of Agriculture, Agricultural Research Service, Washington, DC.)

Table 11: Effects of breakfast consumption on cognitive development[a]

Study	Notable participant characteristics	Intervention and comparator	Outcomes	Results
Adolphus et al. 2021[14] RCT (parallel) UK	Analytic N: 234 Mean age 12y Majority low SES (68% eligible for free school meals) Habitual breakfast consumers: 42.7%; Nearly every day: 23.5%; Rarely consumed: 33.8%"	Experimental condition (breakfast, no breakfast) * time (baseline (-25), +70, +215, post-intervention) interaction	CANTAB test battery: Simple Reaction Time (SRT), 5-Choice Reaction Time (5-CRT), Rapid Visual Information Processing (RVIP), and Paired Associates Learning (PAL)	
			Visual-spatial memory (PAL test): # of levels successfully passed as an effect of intervention	**Cochran-Mantel-Haenszel (CMH) test: 7.29, p<0.01** **Jonckheere-Terpstra (JT) test: z=2.58, p<0.01, when baseline reached level 2 (**JT test NS when baseline reached level 3 or 4). Baseline performance reached level 2, 100% (Intervention) vs. 41.7% (comparator) reached maximum level 4. P value: NR
			Visual-spatial memory (PAL test): Total errors made on the PAL test	**Baseline*intervention interaction: (F[1,202] = 6.95, p < 0.01)** Least square (LS) means NS between breakfast vs. no breakfast when baseline was 0 (t[202]=-1.85); 10 (t[202]=-0.25). **When baseline=50, LS means: t[202]=-2.43, p<0.05**
			SRT	**CMH[1]=8.67, p<0.01** Other SRT outcomes: NS
			5-CRT (ms)	**F[1,204] = 9.90, p<0.01 and baseline*session interaction (F[1,203] = 12.75, p<0.001) (Note: Mean baseline performance the difference between intervention vs comparator significant (t[204]=3.15, p<0.01)** Other 5-CRT outcomes: NS

			Visual-sustained attention	**F[1,202]=6.00, p<0.05, significant baseline*intervention interaction for blocks 3 (F[1,202] = 6.29, p < 0.05) and 4 F[1,202] = 4.01, p < 0.05). Significant baseline*session interaction for block 4 *F*[1,202] = 4.54, *p* < 0.05** NS for blocks 3 (mean baseline 7.44; t(202) = 0.02) and 4 mean baseline 7.42; t(202) = 1.25) across test sessions 1 and 2 **Block 3, LS means significant only when baseline=0 (t[202] = − 2.45, p < 0.05), 2 (t[202] = − 2.41, p < 0.05) and 10 (t[202]2.16, p < 0.05). Block 4, LS means significant only when baseline=9 (t[202] = 2.30, p < 0.05)**
			Visual-sustained attention/RVIP false alarm	**F[1,202]=3.92, p<0.05, significant baseline*intervention interaction (F[1,202] = 8.19, p < 0.01).** LS Mean comparison between breakfast vs. no breakfast was NS when baseline=5.71 across tests 1 and 2 (t(202) = − 0.00. **Significant when baseline=20 (t[202] = 2.58, p < 0.05) and 50 (t[202] = 2.82, p < 0.01) and when baseline =0 (t[202] − 1.98, p < 0.05) (i.e. when there is poorer baseline performance)**
			Visual-sustained attention/Guessing tendency	**(F[1,218]=10.24, p<0.01), significant baseline*intervention interaction (F[1,218] = 9.74, p<0.01);** LS Mean comparison when baseline = 0.84 (t[218] = − 0.76, NS) and 1.00 (t[218] = 1.95) NS **LS mean comparison when baseline = 0.20 (t[202] = − 3.21, p < 0.01) (i.e. breakfast beneficial for test sessions one and two evident for those with a poorer performance at baseline)**
Cooper et al. 2011[5] RCT (crossover) UK	Analytic N: 96 Mean age: 13.3±1.2 Mean BMI: 20.1±3.0	Experimental condition (breakfast, no breakfast) * time (20 min, 120 min after breakfast)	Stroop Test – Response time, main effect	NS, P > 0.05
			Stroop Test – Response time, interaction	• Response times across the morning (trial*session interaction): P > 0.05 • Trial*test level interaction: P > 0.05

	• 3-way interaction test level*session time*test level interaction: P > 0.05
Stroop Test – Accuracy, main effect	**More correct responses in breakfast (vs. no breakfast): 0.01, z(1, 22,973)=2.0, P = 0.04**
Stroop Test – Accuracy, interaction	• **Trial*session time interaction: 0.016, z(1,22,973 =−2.3, P = 0.02** • Complex level (trial*test interaction): 0.011, z(1, 22,973)=−2.0, P > 0.05) • No difference between trials across morning (trial*session time*test level interaction): P > 0.05
Sternberg Paradigm – Response Time, main effect	NS, t(1, 28,225)=2.0, P = 0.051
Sternberg Paradigm – Response Time - Basic	**Breakfast had quicker response times (vs. no breakfast), NR (P < 0.05)**
Sternberg Paradigm – Response Time - Intermediate	No difference between breakfast vs. no breakfast, NR (P > 0.05)
Sternberg Paradigm – Response Time - Advanced	**No breakfast quicker than breakfast, t(1, 28,225)=−2.6, P = 0.010**

Sternberg Paradigm – Response Time, Interaction	Trial*session time interaction: Patterns of change in response time: t(1,28,225)=−1.8, P=0.07)
	• **Significant three-way trial by session time by memory load interaction: t(1, 28,225): 2.5, P = 0.012**
	  ○ **Basic: Greatest improvement across morning for no breakfast (P< 0.05)**
	  ○ Intermediate: Improvement in response times similar across morning for both (P > 0.05)
	  ○ **Advanced: Breakfast had significantly improved response time across the morning P < 0.05**

Sternberg Paradigm – Accuracy, main effect	NS, P > 0.05
Sternberg Paradigm – Accuracy, interaction	• No differences in change of accuracy across the morning (trial*session time), P > 0.05 • Trial memory load interaction, P > 0.05 • 3-way interaction (trial*session time*memory load): P > 0.05
Visual search test – Response time, main effect	NS, P > 0.05

			Visual search test – Response time, interaction	• Trial*session time interaction: Pattern of change not different, P > 0.05 • Effect of breakfast between test levels (trial*test level interaction): P > 0.05 • 3-way interaction: trial*session time* test level: P > 0.05
			Visual search test – Accuracy, main effect	• No main effect of breakfast, P > 0.05 ○ **Breakfast (vs. no breakfast) greater accuracy in the complex level: −0.029, z(1, 16,427)=−2.7, P = 0.007**
			Visual search test – Accuracy, interaction	Trial*session time interaction: Accuracy across morning did not differ by breakfast: P > 0.05
Cooper et al. 2012[6] RCT (crossover) UK	Analytic N: 41 Mean age: 12.8±0.4 Mean BMI: 20.5±3.3	Experimental condition (high-GI breakfast, low-GI breakfast, breakfast omission)*time (+30 min, +120 min)	Flanker Test – Response time, main effect	NS, P>0.05
			Flanker Test – Response time	• High GI vs. no breakfast: P > 0.05 • Low GI vs. no breakfast: P > 0.05
			Flanker Test, interaction	**Change in response time across morning (trial*session time interaction): low GI greater improvements in response time t(1, 13,630): 2.0, P = 0.045**
			Flanker Test - Accuracy	• High GI vs. no breakfast: P > 0.05 • Low GI vs. no breakfast: P > 0.05 • Proportion of correct responses between the trials, NS
			Flanker Test – Accuracy, interaction	**Incongruent (more complex) level:** • **low GI vs. no breakfast: Better accuracy with low GI (trial*session time*test interaction): 0.042, z(1, 14,700), P = 0.001** • high GI vs. no breakfast: NR
			Stroop Test – Response time	• High-GI breakfast vs. no breakfast: t(1, 13530)=1.8, P > 0.05 • **Low GI breakfast vs. no breakfast (120 min): t(1, 9019): 2.6, P=0.009**
			Stroop Test - Accuracy	• **Low GI vs. no breakfast: More correct in low GI: 0.27, z(1, 14820): 3.6, P < 0.001** • High GI vs. no breakfast: P > 0.05
			Sternberg Paradigm – Response Time	• **High GI vs. no breakfast: No breakfast responded quicker than high GI t(1, 17,468): 3.6, P < 0.001** • **Low GI vs. no breakfast: No breakfast responded quicker than low GI t(1, 17,468): 2.5, P =0.01**

			Sternberg Paradigm – Response Time, interaction	• **Greater improvement in response times across morning for low-GI breakfast (trial * session time interaction) t(1, 17438): 2.5, P = 0.01**
			Sternberg Paradigm - Accuracy	• **Low GI vs. no breakfast: More correct response in low GI: 0.01, z(1, 19,520): 2.1, P = 0.04** • High GI vs. no breakfast: $P > 0.05$
			Sternberg Paradigm -interaction	Complex levels (time*test level interaction) low GI vs. no breakfast: 0.025 z(1, 19520): 2.0, $P > 0.05$
Defeyter and Russo., 2013[7] RCT (Crossover) UK	Analytic N: 40 Mean age: 14.2 Lower-middle class children	Experimental condition (Breakfast vs. no breakfast)*time (baseline, +120 min)	Rapid visual information processing-Easy, % correct	Breakfast (T1): 58.69±18.48, Breakfast (T2): 55.65±21.88; No breakfast (T1) 58.55±21.84; No breakfast (T2): 55.37±23.02, $P > 0.05$
			Rapid visual information processing-Easy, Reaction time (ms)	Breakfast (T1): 506.08±37.87, Breakfast (T2): 494.61±42.31; No breakfast (T1): 505.99±45.79; No breakfast (T2): 491.34±41.29, $P > 0.05$
			Rapid visual information processing-Easy	Breakfast*time interaction: $P > 0.05$
			Rapid visual information processing - Easy, analysis of accuracy and reaction time data	No main effects or interaction (Fs < 3.6, $P > 0.05$, largest, $\eta^2 < 0.084$)
			Rapid visual information processing-Hard, % correct	Breakfast (T1): 45.99±15.41; Breakfast (T2); 49.13±17.84; No breakfast (T1): 49.17±12.99, No breakfast (T2): 46.50±17.56, $P > 0.05$
			Rapid visual information processing-Hard, Reaction time (ms)	Breakfast (T1): 502.13±38.62, Breakfast (T2): 502.57±44.0; No breakfast (T1): 500.59±37.08, No breakfast (T2): 493.15±45.05, $P > 0.05$
			Rapid visual information processing-Hard	Breakfast*time interaction: $P > 0.05$
			Rapid visual information processing-Analysis of accuracy and reaction time data	Main effect NS and NS interaction ($Fs < 3.46$, $ps > 0.05$, largest $\eta^2 < 0.081$)
			Choice Reaction Time – Easy, Accuracy	Breakfast (T1): 97.15±3.35, Breakfast (T2): 96.45±2.92; No Breakfast (T1): 96.65±3.18, No Breakfast (T2): 96.70±2.62, $P > 0.05$
			Choice Reaction Time – Easy, Reaction time (ms)	Breakfast (T1): 427.78±63.76, Breakfast (T2): 422.47±63.76; No breakfast (T1): 421.43±59.86; No Breakfast (T2): 423.01±61.27, $P > 0.05$

			Choice Reaction Time – Easy	Breakfast*time interaction: P > 0.05
			Choice Reaction Time – Easy, Analysis of accuracy and reaction time	Analysis of accuracy and reaction time data showed no significant interaction or significant main effects (*Fs* < 1)
			Choice Reaction Time – Hard, Accuracy	Breakfast (T1): 98.08±2.92, Breakfast (T2): 98.13±2.56; No Breakfast (T1): 98.75±2.04; No Breakfast (T2): 98.38±2.13, P > 0.05
			Choice Reaction Time – Hard, Reaction time (ms)	Breakfast (T1): 475.75±61.76, Breakfast (T2): 466.26±60.85; No breakfast (T1): 481.64±60.70, No breakfast (T2): 477.52±84.31, P > 0.05
			Choice Reaction Time - Hard	Breakfast*time interaction: P > 0.05
			Choice Reaction Time – Hard, Analysis of accuracy and reaction time	No significant interaction or significant main effects (*Fs* < 1.83, P > 0.05, largest $\eta^2 < 0.045$)
			Serial subtraction – Easy serial 3's	Breakfast (T1): 31.1 ± 12.3, Breakfast (T2): 32.3 ± 13.0; No breakfast (T1): 35.4 ± 12.5, No breakfast (T2): 31.9 ± 11.5 P > 0.05
			Serial subtraction – Easy serial 3's, main effects	Main effects of breakfast and of time were not significant (*Fs* < 2.64, *p* > 0.05, largest $\eta^2 < 0.064$)
			Serial subtraction – Easy serial 3's, interaction	**Breakfast*time interaction: *F*(1, 39) = 6.23, P < 0.05, η^2 = 0.138**
			Serial subtraction – Hard serial 7's	Breakfast (T1): 20.58 ± 9.7, Breakfast (T2): 21.8 ± 9.3; No breakfast (T1): 21.6 ± 8.6, No breakfast (T2): 19.2 ± 8.7 P > 0.05
			Serial subtraction – Hard serial 7's, main effects	Not significant (F<1)
			Serial subtraction – Hard serial 7's, breakfast*time interaction	**F(1, 39) = 5.25, P < 0.05, η2 = 0.119** Three-way interaction between breakfast*difficulty of task*timing: P > 0.05
Fulford et al. 2016[8] RCT (Crossover) UK	Analytic N: 19 Mean age: 13.3 ± 0.7 y	Experimental condition (Breakfast vs. fasting)	Decision-making task, reaction time	Breakfast: 493.0±76.0 vs. Fasting: 493.3±51.0, P > 0.05
			Decision-making task, number of incorrect responses	Breakfast: 9.7±4.9 vs. Fasting: 8.7±4.1, P > 0.05

			1-back task, reaction time	Breakfast: 543.0±89.0 vs. Fasting: 548.6±88.2, P > 0.05
			1-back task, number of no-response	Breakfast: 2.1±2.3 vs. Fasting: 2.8±3.5, P > 0.05
			1-back task, number of false-positives	Breakfast: 1.6±1.8 vs. Fasting: 1.5±1.9, P > 0.05
			2-back task, reaction time	Breakfast: 611.6±111.6 vs. Fasting: 617.06±100.8, P > 0.05
			2-back task, number of no-response	Breakfast: 8.3±1.2 vs. Fasting: 8.6±3.6, P > 0.05
			2-back task, number of error	Breakfast: 1.5±1.2 vs. Fasting: 2.8±3.6, P > 0.05
Kawabata et al. 2021[2] RCT (parallel) Singapore	Analytic N: 40 Mean age 16y Majority female (78%) Normal BMI	Experimental condition (Breakfast vs fasting) (both conditions included 30 min of exercise at -30min)	Stroop Color-Word Test, Digit-Span and No-Go Task at -30 min	NS (data NR); p>0.05
			Change in reaction time measured by Stroop Color-Word Test at ~+120 min	Congruent: β= 24.39, p>0.05; Incongruent: β= -69.52, p>0.05; Control: β=73.0; p>0.05
			Stroop Color-Word Test, Accuracy (measured at ~+120 min)	Congruent: β= -2.58, p>0.05; Incongruent: β= 0.33, p>0.05; Control: β=0.20; p>0.05
			Change in reaction time, accuracy, interference score from ~+120 min to ~240 min measured by Stroop Color-Word Test	NS (data NR); p>0.05
			Digit span: Maximum number of digits memorized in the forward and backward direction over the study duration	NS (data NR); p>0.05
			No-Go Task reaction time from -30 min to +120 min	**β=33.99, p=0.02**
			No-Go Task reaction time from +120 min to ~240 min	**Findings reversed (β=-15.29, p=0.02)**

			Go/No-Go task error rates	NS (data NR); p>0.05
Kral et al. 2012[10] RCT (Crossover) US	Analytic N: 21 Mean age: 9.2 ± 0.8 y Majority African Americans ~30% overweight	Experimental condition (Breakfast vs. no breakfast)* time (-30, +45, +90, +135 min after breakfast)	Identification task	Breakfast: T1: 2.91±0.02, T2: 2.96±0.02, T3: 2.95±0.01, T4: 2.97±0.02 No breakfast: T1: 2.92±0.01, T2: 2.93±0.02, T3: 2.98±0.02, T4: 2.95±0.02 P > 0.05
			Detection task	Breakfast: T1: 2.77±0.02, T2: 2.80±0.02, T3: 2.80±0.02, T4: 2.81±0.02 No breakfast: T1: 2.77±0.02, T2: 2.78±0.02, T3: 2.78±0.02, T4: 2.80±0.02 P > 0.05
			1-back task	Breakfast: T1: 1.14±0.04, T2: 1.12±0.06, T3: 1.09±0.06, T4: 1.08±0.05 No breakfast: T1: 1.17±0.04, T2: 1.09±0.06, T3: 1.02±0.05, T4: 1.06±0.06 P > 0.05
			1-back task, interaction	Breakfast-condition*time interaction: P > 0.05
			Groton Maze learning test	Breakfast: T1: 73.7±6.19, T2: 76.0±6.51, T3: 82.8±7.62, T4: 73.8±7.67 No breakfast: T1: 70.7±5.30, T2: 78.1±5.75, T3: 80.6±5.60, T4: 82.2±4.96 P > 0.05
			Groton Maze learning test, interaction	Breakfast-condition*time interaction: P > 0.05
			Continuous paired associate learning task	Breakfast: T1: 1.17±0.06, T2: 1.14±0.04, T3: 1.18±0.06, T4: 1.14±0.05 No breakfast: T1: 1.19±0.05, T2: 1.09±0.04, T3: 1.18±0.05, T4: 1.21±0.04
			Continuous paired associate learning task, main effect	NS, P>0.05

			Continuous paired associate learning task, interaction	Breakfast-condition*time interaction: P > 0.05
			Groton maze learning test - delayed recall	Breakfast: T1: 11.2±1.50, T2: 13.5±1.68, T3: 12.1±1.63,T4: 12.2±1.27 No breakfast: T1: 11.8±1.60, T2: 12.2±0.92, T3: 12.4±1.00, T4: 11.4±0.99
			Groton maze learning test - delayed recall, main effect	NS, P>0.05
			Groton maze learning test - delayed recall, interaction	Breakfast-condition*time interaction: P > 0.05
			One Card Learning task	Breakfast: T1: 0.93±0.03, T2: 0.92±0.02, T3: 0.88±0.03, T4: 0.92±0.02 No breakfast (t1, t2, t3, t4): 0.97±0.02, 0.91±0.03, 0.89±0.03, 0.86±0.03
			One Card Learning task, main effect	NS, P > 0.05
			One Card Learning task, interaction	Breakfast-condition*time interaction: P > 0.05
			Chase Test	Breakfast group: T1: 1.00±0.05, T2: 1.13±0.06, T3: 1.16±0.04, T4: 1.18±0.06 No breakfast group: T1: 1.02±0.05, T2: 1.13±0.04, T3: 1.12±0.05, T4: 1.16±0.05
			Chase Test, main effect	NS, P>0.05
			Chase Test, interaction	Breakfast-condition*time interaction: P > 0.05
Iovino et al. 2016[9] RCT (Crossover) US	Analytic N: 128 Mean age: 9.2 ± 0.8 ~72% non-white 50% < $50,000 >50% Free lunch eligible	Experimental condition (Breakfast (Hazelnut spread, Waffles), vs No breakfast)	Digit span, forward	Hazelnut spread: 10.40±0.22, Waffles: 10.14±0.22, No breakfast: 10.23±0.22, P > 0.05

			CPT II Omissions total score	Hazelnut spread: 50.92±1.02, Waffles: 52.53±1.02, No breakfast: 53.73±1.02, P = 0.04, but was not significant after applying Bonferroni correction (P <0.004)
			CPI-II Commissions total score	Hazelnut spread: 48.68±1.04, Waffles: 48.33±1.04, No breakfast: 49.38±1.04, P > 0.05
			Wide range assessment of memory and learning (WRAML2)– Processing speed index	Hazelnut: 105.77±1.18, Waffles: 105.73±1.18, No breakfast: 106.14±1.18, P > 0.05
			WISC-IV Coding	Hazelnut: 10.34±0.24, Waffles: 10.34±0.24, No breakfast: 10.44±0.24, P > 0.05 Sig. difference between different breakfast groups is unknown
			WISC –IV Symbol search	Hazelnut spread: 11.66±0.23, Waffles: 11.60±0.23, No breakfast: 11.65±0.23, P > 0.05
Maffeis et al. 2012[11] RCT (Crossover) Italy	Analytic N: 10 Median age: 9.6	Experimental condition (Breakfast vs No breakfast)*time (baseline, +180 min)	CPT II - Overall Index	**Pre- vs postprandial (error %): 27.3 (4.5) vs 33.7 (6.7), P < 0.05**
			TOMAL– Word selective reminding (percentile)	**Pre vs. Postprandial: 34.2 (2.6) vs. 38.6 (2.3) P < 0.05**
			TOMAL - Visual Sequential memory	Pre, percentile: 88.3 (3.1) vs. Postprandial: 87.1 (7.4), P > 0.05
Mahoney et al. 2016[12] RCT (Crossover) US	Analytic N (Group 1): 30 Analytic N (Group 2): 30 Age range (Group 1): 9-11 y Age range (Group 2): 6-8 y	Experimental condition (Breakfast vs no breakfast)	Visual attention, Group 1	No effect by breakfast type for hits, misses and false alarms, P > 0.05
			Auditory attention, Group 1	No effect by breakfast type for hits or misses, task duration P > 0.05
			Auditory attention, Group 1	**Breakfast type*task duration interaction: F(4, 92)=2.79, P <0.05, MSe=6.22**

Auditory attention, Group 2, hits (M, SEM), Main effect	F(2, 38)=3.54, p <0.05, MSe=123.90; Oatmeal: 36.6, 2.42; RTEC: 26.8, 3.03; No breakfast: 29.5, 2.91 Oatmeal vs. no breakfast: NR; RTEC vs, no breakfast: NR
Auditory attention, Group 2, miss rates, main effect	**F(2, 38)=5.37, P < 0.05, MSe=97.59; Oatmeal: 13.4, 2.36; RTEC: 24.3, 2.65; No breakfast: 17.2, 2.31** **Oatmeal vs. No breakfast: P < 0.05**
Auditory attention, Group 2, false alarms	P>0.05
Auditory attention, Group 2, reaction time to hits	P>0.05
Spatial memory, Group 1, short-term recall	**Main effect**: **F(2, 44)=3.98, P < 0.05, MSe=12.33** • **Short-term recall: Participants correctly recalled most items after oatmeal (17.0±1.12), followed by ready-to-eat cereal (15.7±1.21) and no breakfast (14.0±1.42) P < 0.05** • **Post-hoc analysis of oatmeal vs. no breakfast: P < 0.05** • Incorrect and incorrect location items: P > 0.05
Spatial memory, Group 1, long-term	NS, P > 0.05
Spatial memory, Group 1, short-term, analysis of blanks (M±SEM)	**Main effect: F(2, 44)=3.68, P < 0.05, MSe=8.96** • **Short-term: Oatmeal: 6.0±1.0; No breakfast: 8.4±1.17 (P < 0.05); RTEC (7.1+1.04) vs. No breakfast: NR**
Spatial memory, Group 1, long-term, analysis of blanks (M±SEM)	NS, P > 0.05
Spatial memory, Group 2, short-term recall, correct items	**Breakfast type significantly altered recall of correct items F(2, 40)=3.65, P < 0.05, MSe=13.01** **Oatmeal: 15.9±0.47 vs. No breakfast: 13.0±1.12 (P < 0.05)** RTEC: 14.1, 0.92 vs. No breakfast: 13.0, 1.12 (P > 0.05)
Spatial memory, Group 2, long-term recall, correct items	NS, P>0.05
Spatial memory, Group 2, long-term recall, analysis of blanks	No differences between breakfast conditions on number of countries left blank, P > 0.05
Spatial memory, Group 2, short-term recall, incorrect location items	**Short-term recall: Main effect of breakfast on the analysis of incorrectly placed map items following no breakfast F(2, 40)=3.58, P < 0.05, MSe=12.94 Oatmeal: 2.0, 0.47 vs. No breakfast: 4.9, 1.12 (P < 0.05)** RTEC vs. no breakfast: P > 0.05

Spatial memory, Group 2, long-term recall, incorrect location items	NS, P > 0.05
Short-term memory (digit span-backward), Group 1, interaction	**Breakfast type by sex interaction, F(2, 54)=4.46, P < 0.05, MSe=1.25**
Short-term memory (digit span-backward), Group 1, girls	**Oatmeal vs. no breakfast (M±SEM): 5.0±0.37 vs. 3.9±0.32, P < 0.05**
Short-term memory (digit span-backward), Group 1, boys	Oatmeal vs. no breakfast (M±SEM): 3.8±0.33; 4.4±0.33; P > 0.05
Short-term memory (digit span-backward), Group 2, interaction	**Breakfast type by sex interaction, F(2, 52)=4.74, P < 0.05, MSe=0.67**
Short-term memory (digit span-backward), Group 2, boys	RTEC: 3.3 (0.30); Oatmeal: 3.0 (0.35); No breakfast: 3.1 (0.25); P > 0.05
Short-term memory (digit span-backward), Group 2, girls	RTEC: 2.5 (0.32); Oatmeal: 3.6 (0.37); No breakfast: 2.9 (0.27); P > 0.05
Short-term memory (digit span-forward), Group 1	No significant differences between breakfast types, P > 0.05
Short-term memory (digit span-forward), Group 2	No significant differences between breakfast types, P > 0.05
Visual perception, Group 1, main effect	**F(2, 52)=5.13, P < 0.05, MSe=11.06** **Copy scores better in oatmeal and RTEC vs. no breakfast** **Oatmeal: 31.7, 0.83; RTEC: 31.8, 0.74; No breakfast: 29.3, 0.96; P < 0.05**
Visual perception, Group 1, delayed recall	NS, P > 0.05, data NR
Visual perception, Group 1, long-term memory	NS, P > 0.05, data NR
Visual perception, Group 2	**Copy measure revealed an interaction between breakfast type and sex, F(2, 48)=5.94, p <0.05, MSe=19.50**
Visual perception, Group 2, boys	**Boys: RTEC: 21.3, 2.64; No breakfast: 17.5, 1.67; P < 0.05** Difference in performance was NS for oatmeal (M=21.6, SEM=2.3) vs. no breakfast

			Visual perception, Group 2, girls	**Performance was significantly better after no breakfast than RTEC and oatmeal** **No breakfast: 20.4, 2.25; RTEC: 15.8, 2.37; Oatmeal: 19.0, 1.71; P < 0.05**
Widenhorn-Muller, 2008[13] RCT (Crossover) Germany	Analytic N: 104 Mean age: 17.2 ± 1.6 y	Experimental condition (breakfast vs. no breakfast)	Sustained attention – Total number of items processed, main effects	NS, P > 0.05; • Male: Breakfast: 371.00±62.48; No breakfast: 372.30±58.13, P > 0.05 • Female: Breakfast: 390.56±74.51; No breakfast: 371.96±61.70, P > 0.05
			Sustained attention – Total number of items processed, interaction	**Breakfast*group interaction: P< 0.05**
			Sustained attention – Concentration performance, main effects	NS, P > 0.05 • Male: Breakfast: 138.05±28.59; No breakfast: 137.961±25.72, P > 0.05 • Female: Breakfast: 150.40±27.87; No breakfast:141.16±23.17, P > 0.05
			Sustained attention – Concentration performance, interaction	**Breakfast*group interaction: F=134.73, P< 0.001**
			Sustained attention – Number of errors, main effects	NS, P > 0.05; • Males: Breakfast: 19.02±18.45; No breakfast: 19.86±21.45, P > 0.05 • Female: Breakfast: 14.28±10.49; No breakfast: 16.92±12.72
			Sustained attention – Number of errors, interaction	Breakfast*group interaction: P > 0.05
			LGT-3, total score, main effect	NS, P > 0.05 • Males: Breakfast: 43.02±11.38; No breakfast: 42.12±10.77, P > 0.05 • Females: Breakfast: 51.76±12.69, No breakfast: 50.14±11.67, P > 0.05
			LGT-3, objects, main effect	Main effect: NR • Males: Breakfast: 8.28±3.13; No breakfast:8.11±3.08, P > 0.05 • Females: Breakfast: 11.30±3.58, No breakfast: 10.78±3.13, P > 0.05
			LGT-3, overall verbal memory	No main effect, P > 0.05 • Males: Breakfast: 43.22±10.92, No breakfast: 43.80±8.83, P > 0.05 • Females: Breakfast: 49.68±9.90, No breakfast: 47.82±10.18, P > 0.05

			LGT-3, Turkish vocabulary	• Male: Breakfast: 9.11±3.58, No breakfast: 9.57±3.26, P > 0.05 • Female: Breakfast: 11.96±3.46, No breakfast: 12.00±3.62, P > 0.05
			LGT-3, telephone numbers	• Males: Breakfast: 4.83±2.68; No breakfast:4.74±3.10, P > 0.05 • Females: Breakfast: 6.06±3.19, No breakfast: 5.74±3.15 P > 0.05
			LGT-3, telephone numbers, interaction	• **Breakfast*group interaction: P < 0.001**
			LGT-3, Cued recall subtests	• Males: Breakfast: 9.54±3.81; No breakfast: 9.63±4.29, P > 0.05 • Females: Breakfast: 11.26±4.14; No breakfast: 10.08±4.63, P > 0.05
			LGT-3, Cued recall subtests, interaction	**Breakfast*group interaction: P < 0.001, only for girls**
			Overall visuospatial memory, main effect	F= 4.95, P = 0.028 • **Male: Breakfast: 48.79±9.91, No breakfast: 45.47±9.51, F=5.38, P =0.024** • Female: Breakfast: 51.18±11.76, No breakfast: 50.56±10.11, P > 0.05
			Overall visuospatial memory, interaction	**Breakfast*group interaction: P=0.035, for boys only**
			Overall visuospatial memory, trail	• Males: Breakfast: 17.02±5.55; No breakfast: 17.19±5.72, P > 0.05 • Females: Breakfast: 17.66±5.09; No breakfast: 17.02±6.04, P > 0.05
			Overall visuospatial memory, logos	• Males: Breakfast: 10.33±3.35; No breakfast: 9.43±3.26, P > 0.05 • Females: Breakfast: 11.54±3.91; No breakfast: 11.34±2.95, P > 0.05
Zipp, 2019[15] RCT (Crossover) Germany	Analytic N: 845 Mean age: NR (Grades 3-12)	Test procedure with intervention (standardized breakfast meal at ~9:30 am) Test procedure without intervention (without breakfast meal, but were	Cognitive information processing (KAI: general intelligence) (mean±SD)	**Work memory capacity, breakfast grp: 75.24±27.15; Work memory capacity, no breakfast grp: 77.49 ± 29.06; P≤0.001** *(It seems like breakfast and no breakfast groups are flipped in table 3. Data, reported as is from the publication)*

provided mineral water)		
	Cognitive information processing (KAI: general intelligence), primary school pupils, without breakfast at home, (mean±SD)	No breakfast in school (n=104): 60.1±20.5; Breakfast in school (n=104): 63.1±20.8; P=NS
	Cognitive information processing (KAI: general intelligence), primary school pupils, with breakfast at home, (mean±SD)	No breakfast in school (n=238): 62.4±20.3; Breakfast in school (n=238): 63.5±21.8; P=NS
	Cognitive information processing (KAI: general intelligence), secondary school pupils, without breakfast at home (mean±SD)	**No breakfast in school (n=92): 98.8±24.8; Breakfast in school (n=92): 104.3±28.6; P=0.024**
	Cognitive information processing (KAI: general intelligence), secondary school pupils, with breakfast at home (mean±SD)	No breakfast in school (n=93): 104.3±25.8; Breakfast in school (n=93): 107.9±26.0; P=NS
	Concentration (KT 3-4 R: General performance) - Total correct answers (mean±SD)	**Breakfast grp: 104.75±45.23; No breakfast grp: 107.29±45.90; P≤0.001** *(It seems like breakfast and no breakfast groups are flipped in table 3. Data, reported as is from the publication)*
	Concentration (KT 3-4 R: General performance) - Total number of cubes (mean±SD)	**Breakfast grp: 108.62±45.79; No breakfast grp: 111.27±46.58; P≤0.001** *(It seems like breakfast and no breakfast groups are flipped in table 3. Data, reported as is from the publication)*
	Concentration (KT 3-4 R: General performance) – Concentration performance (mean±SD)	**Breakfast grp: 31.15±14.34; No breakfast grp: 31.83±14.52; P=0.004** *(It seems like breakfast and no breakfast groups are flipped in table 3. Data, reported as is from the publication)*
	Concentration (KT 3-4 R: General performance) – Concentration performance, primary school pupils without breakfast at home, total correct answer (mean±SD)	**No breakfast in school (n=104): 77.2±28.4; Breakfast in school (n=104): 82.1±28.0; P=0.009**

Concentration (KT 3-4 R: General performance) – Concentration performance, primary school pupils without breakfast at home, total number of cubes (mean±SD)	**No breakfast in school (n=104): 80.3±29.3; Breakfast in school (n=104): 85.7±28.7; P=0.006**
Concentration (KT 3-4 R: General performance) – Concentration performance, primary school pupils without breakfast at home, concentration performance (mean±SD)	No breakfast in school (n=104): 23.1±9.4; Breakfast in school (n=104): 24.1±9.6; P=NS
Concentration (KT 3-4 R: General performance) – Concentration performance, primary school pupils with breakfast at home, total correct answer (mean±SD)	**No breakfast in school (n=238): 81.1±28.5; Breakfast in school (n=238): 84.1±30.4; P=0.022**
Concentration (KT 3-4 R: General performance) – Concentration performance, primary school pupils with breakfast at home, total number cubes (mean±SD)	**No breakfast in school (n=238): 84.5±28.7; Breakfast in school (n=238): 87.5±31.0; P=0.028**
Concentration (KT 3-4 R: General performance) – Concentration performance, primary school pupils with breakfast at home, concentration perfomance (mean±SD)	**No breakfast in school (n=238): 24.1±9.6; Breakfast in school (n=238): 25.0±10.0; P=0.021**
Concentration (KT 3-4 R: General performance) – Concentration performance, secondary school pupils without breakfast at home, total correct answer (mean±SD)	**No breakfast in school (n=92): 149.3±35.1; Breakfast in school (n=92): 158.0±32.6; P≤0.000**
Concentration (KT 3-4 R: General performance) – Concentration performance, secondary school pupils without breakfast at home, total number cubes (mean±SD)	**No breakfast in school (n=92): 154.2±35.3; Breakfast in school (n=92): 162.6±33.4; P≤0.000**
Concentration (KT 3-4 R: General performance) – Concentration	**No breakfast in school (n=92): 44.5±11.3; Breakfast in school (n=92): 47.3±9.8; P=0.001**

			performance, secondary school pupils without breakfast at home, concentration perfomance (mean±SD)	
			Concentration (KT 3-4 R: General performance) – Concentration performance, secondary school pupils with breakfast at home, total correct answer (mean±SD)	No breakfast in school (n=93): 159.8±35.2; Breakfast in school (n=93): 159.5±32.1; P=NS
			Concentration (KT 3-4 R: General performance) – Concentration performance, secondary school pupils with breakfast at home, total number cubes (mean±SD)	No breakfast in school (n=93): 163.8±35.7; Breakfast in school (n=93): 163.3±32.6; P=NS
			Concentration (KT 3-4 R: General performance) – Concentration performance, secondary school pupils with breakfast at home, concentration perfomance (mean±SD)	No breakfast in school (n=93): 48.1±11.1; Breakfast in school (n=93): 48.2±9.6; P=NS
Smith, 2010[16] NRCT UK	Analytic N: 213 Mean age: 8.1±2.0	Daily a*d libitum* consumption of self-selected RTEC vs. children that does not normally eat breakfast	Cognitive difficulties	Day 7 **Cornflakes: 17.7 (SE: 0.7), Rice Krispies: 15.0 (SE: 0.7), Muddles: 14.6 (SE: 0.8) vs. No breakfast: 20.4 (SE: 1.0) P < 0.001** Day 14 **Cornflakes: 15.6 (SE: 0.7), Rice Krispies: 14.3 (SE: 0.6), Muddles: 13.7 (SE: 0.7) vs. No breakfast: 18.2 (SE: 0.9) P < 0.001**
			Alertness	**Day 7** **Before breakfast: Cornflakes: 430 (SE: 18), Rice Krispies: 459 (SE: 17), Muddles1: 498 (SE: 19) vs. No cereal: 377 (SE: 24) P < 0.001** **After breakfast: Cornflakes: 611 (SE: 13), Rice Krispies: 617 (SE: 12), Muddles1: 653 (SE: 14) vs. No breakfast: 583 (SE: 17) P < 0.05** **Day 14** **Before breakfast: Cornflakes: 434 (SE: 18), Rice Krispies: 474 (SE: 18), Muddles1: 501 (SE: 20) vs. No cereal: 414 (SE: 25) P < 0.05**

				After breakfast (one-tailed test): Cornflakes: 635 (SE: 13), Rice Krispies: 640 (SE: 12), Muddles1: 674 (SE: 13) vs. No breakfast: 623 (SE: 18) P<0.05
Liu, 2021[17] Prospective Cohort Study China	Analytic N: 511 (longitudinal); 835 (cross-sectional) Mean age of exposure: 6 y Mean age of outcome assessment: 12 y	<u>Intervention</u>: Breakfast consumption at 6 y, assessed using a questionnaire completed by parents Breakfast consumption at 12 y, assessed using a questionnaire completed by children	At age 12: Cognition assessed using Wechsler Intelligence Scale for Children-Revised (WISC- R); VIQ, PIQ and FIQ (combination of VIQ and PIQ); Academic Performance	
			Breakfast consumption at 6 y and IQ during wave 2, VIQ:	**≤ 3d/w (n=27): 94.7±12.2; ≥4d/w (n=484): 101.9±11.4; P=0.002**
			Breakfast consumption at 6 y and IQ during wave 2, PIQ:	≤ 3d/w (n=27): 105.0±12.7; ≥4d/w (n=484): 106.6±12.2; P=0.503
			Breakfast consumption at 6 y and IQ during wave 2, FIQ:	**≤ 3d/w (n=27): 99.6 ± 12.9; ≥4d/w (n=484: 105.0±11.9; P=0.021**
			Multivariable mixed model, Breakfast always or often vs. sometimes or rarely, VIQ	**5.54 (1.42); P<0.001**
			Multivariable mixed model, Breakfast always or often vs. sometimes or rarely, PIQ	2.20 (1.38); P=0.113

Multivariable mixed model, Breakfast always or often vs. sometimes or rarely, FIQ	**4.35 (1.31); P=0.001**
Categorical breakfast consumption Combination of wave (w) 1 and 2 (n=504) - More wave 1 + more wave 2 (n=454), VIQ	**19.81 (5.46), P<0.001**
Fewer wave 1 + fewer wave 2 (n=5): VIQ: Ref; PIQ: Ref; FIQ: Ref	
Categorical breakfast consumption Combination of wave (w) 1 and 2 (n=504) - More wave 1 + more wave 2 (n=454), PIQ	0.30 (6.05), P=0.96
Categorical breakfast consumption Combination of wave (w) 1 and 2 (n=504) - More wave 1 + more wave 2 (n=454), FIQ	**12.95 (5.71); P=0.024**
Categorical breakfast consumption Combination of wave (w) 1 and 2 (n=504)- Fewer wave 1 + more wave 2 (n=21): VIQ	**17.66 (5.93), P=0.003**
Categorical breakfast consumption Combination of wave (w) 1 and 2 (n=504)- Fewer wave 1 + more wave 2 (n=21): PIQ	0.33 (6.57), P=0.96
Categorical breakfast consumption Combination of wave (w) 1 and 2 (n=504)- Fewer wave 1 + more wave 2 (n=21): FIQ	11.99 (6.21), P=0.054
Categorical breakfast consumption Combination of wave (w) 1 and 2 (n=504)- More wave 1 + fewer wave 2 (n=24): VIQ	**15.90 (6.01), P=0.008**
Categorical breakfast consumption Combination of wave (w) 1 and 2 (n=504)- More wave 1 + fewer wave 2 (n=24): PIQ	-0.90 (6.66), P=0.89

			Categorical breakfast consumption Combination of wave (w) 1 and 2 (n=504)- More wave 1 + fewer wave 2 (n=24): FIQ	9.87 (6.29), P=0.12
Benton et al. 2007[19] Cross-Sectional UK	Analytic N: 20 Mean age: 9.4	Exposure: Based on nutrition composition of habitual breakfast intake for 4 days 1. >230 kcal 2. 151-230 kcal Comparator: <150 kcal	Time of task	**Those eating a breakfast of <150 kcal spend significantly less time on task than those who had eaten a larger meal (P < 0.03)** **Children who had eaten a breakfast <150 kcal and consumed no snack were significantly more likely to be distracted than those who had eaten more (P < 0.03)**
Peña-Jorquera, 2021[20] Cross-sectional Chile	Analytic N: 1181 Mean age: 11.7±1.06 Cognitive test score at baseline (P<0.001) Overall: 100.0±8.8 Normal BMI: 100.5±8.8 OW/OB BMI: 99.6±8.9 Skipping breakfast regularly (P<0.001) (Yes (Y), No, (N)) Overall: Y: 24.0%; N: 76.0% Normal BMI: Y: 9.5%; N: 38.7% Overwt/Obese BMI: Y: 14.6%; N: 37.2%	Have breakfast (Yes/No) Breakfast quality score computed according to EndKid Study criteria, assessing yes for the following: a) cereals/bread, b) dairy, c) fruits or natural juice without sugar in breakfast	Neurocognitive performance test	**Have breakfast before a cognitive test: F(6, 796)=9.67; P<0.001; η^2p=0.007** **By BMIz: F(7, 795)=8.31; P<0.001; η^2p=0.007**
			Neurocognitive performance test	**Breakfast quality score: F(11, 805)=6.04; P<0.001; η^2p=0.008** **By BMIz: F(11, 794)=3.96; P<0.001; η^2p=0.010**
Wesnes, 2012[18] Cross-sectional	Analytic N: 1386 Mean age: 10.4±2.0	Exposure: Breakfast consumed, the	Power of attention	**Breakfast: 1,505±13.6 vs. No breakfast: 1,609±35.5, F(1,1372) = 7.4, P = 0.007**

UK	morning of assessment Comparator: No breakfast		Participants who had breakfast were faster on the power of attention factor score **Significant interaction between breakfast and gender for power of attention (F(1,1372) = 4.6, P = 0.03)**
		Response speed variability (CV%)	**Breakfast: 109±1.1 vs. No breakfast: 120±2.8,** **F(1,1366) = 12.5, P = 0.0004** Participants who had breakfast showed lower response speed variability
		Choice Reaction Time (%)	Breakfast: 84.1±0.36 vs. No breakfast: 84.0±0.95, P > 0.05
		Digit vigilance targets detected (%)	**Breakfast: 75.1±0.5 vs. No breakfast: 69.6±1.3 F(1,1379) = 14.3, P = 0.0002** Participants who had breakfast detected more targets
		Digit vigilance – false alarms (#)	**Breakfast: 20.1±0.5 vs. No breakfast: 24.8±1.3 F(1,1379) = 11.7, P = 0.0006**

[a] Abbreviations: BMI Body Mass Index; CANTAB: Cambridge Neuropsychological Test Automated Battery; CPT Continuous Performance Test; FIQ: Full IQ; IQ Intelligence Quotient; LGT3 Lern- und Gedaechtnistest; PIQ: Performance IQ; RCT Randomized controlled trials; RTEC Ready-to-eat-cereal; SES Socio-economic status; TOMAL The Test of Memory and Learning; VIQ: Verbal IQWIAT Wechsler Individual Achievement Test; WISC Wechsler Intelligence Scale for Children; WRAT Wide Range Achievement Test; WRAML Wide range assessment of memory and learning

Table 12: Risk of bias for the randomized controlled trial examining the effects of breakfast consumption on cognitive development[a]

Article	Randomization	Period and carryover effects	Deviations from intended interventions	Missing outcome data	Outcome measurement	Selection of the reported result
Adolphus et al. 2021[14] Parallel RCT	**SOME CONCERNS** Allocation sequence may not be concealed	**N/A**	**LOW**	**LOW**	**LOW**	**SOME CONCERNS** Retrospective protocol
Cooper et al. 2011[5] Crossover RCT	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**SOME CONCERNS** No registered protocol reported
Cooper et al. 2012[6] Crossover RCT	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**SOME CONCERNS** No registered protocol reported
Defeyter & Russo, 2013[7] Crossover RCT	**LOW**	**LOW**	**LOW**	**LOW**	**SOME CONCERNS** Lack of participant blinding may have affected participant-reported outcomes	**SOME CONCERNS** No registered protocol reported
Fulford et al. 2016[8] Crossover RCT	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**SOME CONCERNS** No registered protocol reported
Iovino et al. 2016[9] Crossover RCT	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**
Kawabata et al. 2021[2] Parallel RCT	**SOME CONCERNS** Baseline differences between groups may relate to randomization or outcome measurement	**N/A**	**LOW**	**LOW**	**LOW**	**SOME CONCERNS** No registered protocol reported
Kral et al. 2012[10] Crossover RCT	**SOME CONCERNS** Minimal information on randomization or baseline status	**LOW**	**LOW**	**LOW**	**LOW**	**SOME CONCERNS** No registered protocol reported

Maffeis et al. 2012[11] Crossover RCT	LOW	LOW	LOW	LOW	LOW	SOME CONCERNS No registered protocol reported
Mahoney et al. 2005[12] Crossover RCT	SOME CONCERNS Minimal information on randomization or baseline status	LOW	SOME CONCERNS Minimal information reported	LOW	LOW	SOME CONCERNS No registered protocol reported
Widenhorn-Muller et al. 2008[13] Crossover RCT	LOW	LOW	LOW	LOW	LOW	LOW
Zipp and Eissing, 2019[15] Crossover RCT	SOME CONCERNS Minimal information on randomization or baseline status	HIGH Carryover effect may not have disappeared	HIGH Impact on the results since participants were not analyzed in the allocated group	HIGH Participants might have been excluded because of poor performance	HIGH Outcome measurement may not have been appropriate	SOME CONCERNS No registered protocol reported

Table 13: Risk of bias for the non-randomized controlled trial examining the effects of breakfast consumption on cognitive development[b]

Article	Confounding (Key confounders: age, sex, race/ethnicity, physical activity)	Selection of participants	Classification of interventions	Deviations from intended interventions	Missing data	Outcome measurement	Selection of the reported result
Smith, 2010[16]	CRITICAL None of the key confounders accounted for	LOW	LOW	LOW	LOW	MODERATE Outcome maybe influenced by knowledge of exposure	LOW

Table 14: Risk of bias for the observational studies examining the association between breakfast consumption on cognitive development[c]

Article	Confounding	Selection of participants	Classification of exposures	Deviations from intended exposures	Missing data	Outcome measurement	Selection of the reported result

	(Key confounders: age, sex, SES, race/ethnicity, physical activity)						
Benton and Jarvis, 2007[19]	**CRITICAL** Confounding inherently present	**NO INFORMATION**	**SERIOUS** Methods for assessing exposure not valid	**NO INFORMATION**	**NO INFORMATION**	**SERIOUS** Outcome influenced by knowledge of exposure	**NO INFORMATION**
Liu et al. 2021[17]	**SERIOUS** Key confounders (age, physical activity, BMI) not accounted for	**MODERATE** Start of follow-up and exposure may not have coincided	**SERIOUS** Methods for assessing exposure may not be valid	**LOW**	**NO INFORMATION**	**LOW**	**MODERATE** No pre-registered protocol
Peña-Jorquera et al. 2021[20]	**SERIOUS** Key confounders (age, race/ethnicity, SES) not accounted for	**NO INFORMATION**	**MODERATE** Breakfast intake self-reported	**MODERATE** BMI was different and varied by cognitive test scores	**NO INFORMATION** All results were obtained from figures	**MODERATE** Outcome could have been influenced by the exposure	**MODERATE** No pre-registered protocol
Wesnes et al. 2012[18]	**CRITICAL** Confounding inherently present	**NO INFORMATION** No information on how many schools contacted agreed to participate. No data on how many of the contacted students participated	**SERIOUS** Lack of information on how exposure was assessed	**NO INFORMATION** No data on co-exposure	**LOW**	**LOW**	**MODERATE** No pre-registered protocol

ᵃ Possible ratings of low, some concerns, or high determined using the "Cochrane Risk-of-bias 2.0" (RoB 2.0) (August 2016 version)" (Higgins JPT, Sterne JAC, Savović J, Page MJ, Hróbjartsson A, Boutron I, Reeves B, Eldridge S. A revised tool for assessing risk of bias in randomized trials In: Chandler J, McKenzie J, Boutron I, Welch V (editors). Cochrane Methods. *Cochrane Database of Systematic Reviews* 2016, Issue 10 (Suppl 1). https://doi.org/10.1002/14651858.CD201601.)

ᵇ Possible ratings of low, moderate, serious, critical, or no information determined using the "Risk of Bias in Non-randomized Studies of Interventions (ROBINS-I) tool" (Sterne JAC, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, Henry D, Altman DG, Ansari MT, Boutron I, Carpenter JR, Chan AW, Churchill R, Deeks JJ, Hróbjartsson A, Kirkham J, Jüni P, Loke YK, Pigott TD, Ramsay CR, Regidor D, Rothstein HR, Sandhu L, Santaguida PL, Schünemann HJ, Shea B, Shrier I, Tugwell P, Turner L, Valentine JC, Waddington H, Waters E, Wells GA, Whiting PF, Higgins JPT. ROBINS-I: a tool for assessing risk of bias in non-randomized studies of interventions. BMJ 2016; 355; i4919; https://doi.org/10.1136/bmj.i4919.)

[c] Possible ratings of low, moderate, serious, critical, or no information determined using the "Risk of Bias for Nutrition Observational Studies" tool
Advisory Committee. 2020. *Scientific Report of the 2020 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Agriculture*
Human Services. U.S. Department of Agriculture, Agricultural Research Service, Washington, DC.)

Key Question 1b: What is the relationship between eating breakfast and weight-related outcomes?

Evidence on the associations between breakfast intake and weight-related outcomes shares many similarities across the three groups of school-aged participants discussed above. The majority of studies assessed breakfast intake at baseline only. Breakfast intake was most commonly assessed using a single question, such as ‘Do you eat breakfast? Y/N’ or ‘How many times in the past week have you eaten breakfast?’ Very few studies gave guidance on how participants should define breakfast or how to answer yes/no questions if the answer was nuanced. There was also marked heterogeneity in how the intake categories were defined across studies. For instance, one study categorized ‘breakfast skipping’ as skipping breakfast every day, while others defined it as eating breakfast 0-3 times per week. Comparability across studies was limited as a result.

Outcomes of interest also remained fairly consistent across studies, with most examining either BMI (often as z-scores) or weight status (most often defined as overweight: ≥85th percentile and obesity as ≥95th percentile on sex- and age-specific growth charts). A small number of studies examined outcomes such as abdominal obesity and percent fat mass, but the evidence base was very small.

The full body of evidence is strengthened by large sample sizes and long follow-up periods, with almost all studies following participants for at least two years. However, this body of evidence is also affected by multiple, similar limitations including predominantly observational study designs, inconsistent methods for measuring and quantifying breakfast intake, measuring intake at baseline only despite long follow-up periods, and findings that – while statistically significant – have unclear practical significance.

Evidence synthesis – Breakfast intake during childhood and weight-related outcomes

The evidence synthesized here is presented in **Table 15** and described in the results section Description of the evidence: Breakfast intake during childhood and weight-related outcomes.

The largest body of evidence in this rapid review examined breakfast intake in childhood (5-9 years) and contributed large sample sizes and substantial racial/ethnic and SES diversity, overall. Three-quarters of the evidence in children measured overall breakfast intake, though the methods varied across studies, which limits interpretation. An additional three studies asked about breakfast eating at home, which shows the highest prevalence in this youngest school-aged population. Therefore, asking about breakfast intake overall and breakfast intake at home, specifically, likely represents a very similar exposure.

Findings for overall breakfast intake were inconsistent across studies. All studies examined either BMI or weight status, and roughly half found a significant, beneficial association between greater frequency of breakfast intake and healthier BMI or weight status. The other half found no significant association between breakfast intake and BMI or weight status. This discrepancy does not appear to be explained by sample size, breakfast definition, whether breakfast intake was measured at baseline only versus repeatedly, or length of follow up.

The evidence for location-specific breakfast intake (e.g., home, school) was much smaller and therefore more difficult to draw conclusions around. All studies measured intake at baseline only despite follow up of two to five years. Two of the three studies on breakfast at home found an association between greater frequency and healthier BMI, while the third found no significant association. Both studies on school breakfast found a detrimental association between more frequent intake and BMI change. However, given the number of studies that assessed overall breakfast intake without gather location information, it is difficult to disentangle the exposure measurements across studies or draw any conclusions around associations by breakfast location.

Additional outcomes of interest, including abdominal obesity and waist-to-height ratio, were examined in one cohort only, which prevented conclusions from being drawn for this age group.

This body of evidence reflects a relatively large number of studies, particularly examining the association between overall breakfast intake and BMI or weight status. Most studies in this body of evidence also enrolled large samples, with only three studies[24,43,52] enrolling fewer than 900 participants. However, in addition to the limitations discussed above for the full body of evidence, numerous limitations affected this body of evidence, specifically, primarily high attrition, with multiple studies reporting >40% loss to follow up. **Table 16** contains the risk of bias assessments for these studies.

Summary statement: Breakfast intake in childhood (5-9y)

Increased frequency of breakfast intake in childhood (5-9y) may be associated with healthier weight-related outcomes, though roughly half of the studies found no statistically significant association. No studies examining overall breakfast intake found an association with greater frequency and less healthy outcomes. These studies enrolled large cohorts of participants with substantial diversity in race/ethnicity and socioeconomic status, as well as long follow-up periods, but they were also limited by high attrition, inconsistent definitions of breakfast, and intake assessments at baseline only.

The association between breakfast intake and other weight-related outcomes of interest is unclear due to a lack of evidence.

Evidence synthesis – Breakfast intake during early adolescence and weight-related outcomes

The evidence synthesized here is presented in **Table 17** and described in the results section Description of the evidence: Breakfast intake during early adolescence and weight-related outcomes.

The evidence on breakfast intake during the early adolescent years (10-12 years) was similar to the childhood evidence in that studies primarily measured overall breakfast intake and its association with BMI or weight status. Findings were again equally split between studies showing a beneficial association between breakfast intake and BMI and weight status and those finding no significant association.

Location-specific breakfast intake was consistently not associated with BMI or weight status, and this was true for both school breakfast and breakfast at home.

In addition to the limitations discussed above for the full body of evidence, this body of evidence was also limited by overlap in age groups (e.g., enrolling participants 11-14 years old) and smaller samples than the studies in childhood or later adolescence. **Table 18** contains the risk of bias assessments for these studies.

Summary statement: Breakfast intake in early adolescence (10-12y)

Increased frequency of breakfast intake in early adolescence (10-12y) may be associated with healthier weight-related outcomes, particularly lower BMI and healthier weight status, though roughly half of the studies found no statistically significant association. No studies found an association between increased breakfast intake and less healthy BMI or weight status. These studies included long follow-up periods but were limited by high attrition, small sample sizes, greater age group overlap, inconsistent definitions of breakfast, and intake assessment at baseline only.

The association between breakfast intake in early adolescence and other weight-related outcomes is unclear due to a lack of evidence.

Evidence synthesis – Breakfast intake during later adolescence and weight-related outcomes

The evidence synthesized here is presented in **Table 19** and described in the results section Description of the evidence: Breakfast intake during later adolescence and weight-related outcomes.

The associations between increased breakfast intake and healthier weight-related outcomes appear more consistently in older adolescents, though certain outside factors may be impacting that association. For instance, eight studies in older adolescents came from two cohorts, potentially making the full body of evidence for this age group appear more consistent than if findings were from independent cohorts. None of the other cohorts in this body of evidence found significant associations. Furthermore, the increased prevalence of breakfast skipping in this older population compared to the younger groups may contribute to these findings by increasing variability and ability to detect an association.

Older adolescents were not asked about location-specific breakfast intake in this body of evidence, so no conclusions can be made in those areas. Similar to the other bodies of evidence, additional weight-related outcomes were rarely studied, so conclusions cannot be drawn.

Repeat exposure assessment was far more common in the later adolescent populations, strengthening findings by allowing researchers to examine how intake patterns across time relate to the outcomes of interest across the same periods. However, in addition to the limitations discussed above for the full body of evidence, the evidence in older adolescents was limited by high attrition and findings with unclear practical significance. **Table 20** and **Table 21** contain the risk of bias assessments for these studies.

Summary statement: Breakfast intake in later adolescence (13y+)

Increased frequency of breakfast intake in later adolescence (13y+) showed a more consistent association with healthier weight-related outcomes than in younger populations, particularly for BMI and weight status, with eight of twelve studies supporting that finding. However, these eight studies came from only two cohorts, and the remaining four studies from other cohorts did not find statistically significant associations. No studies found an association between greater breakfast intake and less healthy BMI or weight status. These studies enrolled large cohorts of participants with substantial diversity in race/ethnicity and socioeconomic status, as well as long follow-up periods, but they were limited by high attrition and intake assessments at baseline only.

The association between breakfast intake in later adolescence and other weight-related outcomes is unclear due to a lack of evidence.

Research recommendations

The development of a stronger evidence base around the question of breakfast intake and weight-related outcomes could be facilitated by additional research that:

- Uses valid and reliable measures, particularly for the key variables of interest, such as dietary intake and BMI
- Assesses the exposure repeatedly rather than at baseline only to identify change over time and its relationship with the outcomes of interest
- Determines the components of breakfast intake, such as location, timing, or amount, that predict the most beneficial long-term outcomes
- Adjusts for key confounders and examines potential mediators and moderators
- Focuses on more diverse racial/ethnic and socioeconomic groups to increase generalizability

- Examines other indicators of healthy growth, such as waist-to-height ratio and percent body fat. While these were assessed in a small number of studies in this body of literature, evidence was too limited to draw conclusions

Rapid review conclusions in context of existing narrative review

Primarily cross-sectional data looking at the relationship between breakfast intake and weight-related outcomes were available when the existing narrative review[a] was published. The numerous prospective studies conducted since then and detailed in this report serve to strengthen the conclusions made on the relationship between breakfast and weight-related outcomes.

For the question of breakfast intake and weight-related outcomes, evidence from 1999 to 2004 was included in the existing review. The cross-sectional data concluded that breakfast intake was associated with weight-related outcomes. Specifically, participants who reported more frequent breakfast skipping were more likely to be overweight or have obesity. Although cross-sectional data were not included in this present review, the findings from that narrative review parallel those detailed here.

The conclusions drawn in the present rapid review parallel those of the existing narrative review with the added benefit of stronger study designs and a larger body of evidence. Findings from stronger study designs included in this review support the conclusion that more frequent breakfast intake may be associated with healthier weight-related outcomes. However, as with the older review, inconsistency in findings is still reported. A substantial number of studies found no relationship between breakfast intake and weight-related outcomes.

There remains a lack of sufficient evidence to evaluate the unique impact of breakfast consumed in specific locations, such as home or school. The impact of breakfast intake on other weight-related outcomes, such as waist circumference, are also not able to be determined.

[a] Murphy, JM. Breakfast and learning: an updated review. *Current Nutrition & Food Science.* 2007; 3(1):3-36. https://doi.org/10.2174/1573401310703010003.

Table 15: Evidence examining the relationship between breakfast intake in childhood (5-9 years) and weight-related outcomes[a]

Study	Notable participant characteristics	Intervention and comparator	Outcomes	Results
Affenito, 2005[21] PCS, NHLBI Growth and Health Study USA	Analytic N: ~2,117 Baseline age: 9y 100% Female 51% Non-Hispanic Black >70% family income <$50,000 BMI: 18.6±3.8 kg/m^2	Average breakfast intake across all time periods (i.e., % of days with any eating between 5 AM and 10 AM on weekdays or 5 AM to 11 AM on weekend) Assessed every 1-2y from age 9-18y using 3-day recall	BMI across time, chi-square, p-value Breakfast intake:	 3.10, p=0.38
Albertson, 2007[22] PCS, NHLBI Growth and Health Study USA	Analytic N: ~2,117 Baseline age: 9y 100% Female 51% Non-Hispanic Black >70% family income <$50,000 BMI: 18.6±3.8 kg/m^2	Average breakfast intake across all time periods (i.e., % of days with any eating between 5 AM and 10 AM on weekdays or 5 AM to 11 AM on weekend) Assessed every 1-2y from age 9-18y using 3-day recall	BMIZ at 18y, R (95% CI), p-value • Baseline BMI at 50th percentile: • Baseline BMI at 95th percentile: • Baseline BMI at 97th percentile:	 0.02 (-0.01, 0.05), p>0.05 **-0.04 (-0.08, -0.01), p=0.04** **-0.05 (-0.10, -0.01), p=0.01**
Barton, 2005[23] PCS, NHLBI Growth and Health Study USA	Analytic N: ~2,117 (unclear) Baseline age: 9y 100% Female 51% Non-Hispanic Black >70% family income <$50,000 BMI: 18.6±3.8 kg/m^2	Average breakfast intake across all time periods (i.e., % of days with any eating between 5 AM and 10 AM on weekdays or 5 AM to 11 AM on weekend) Assessed every 1-2y from age 9-18y using 3-day recall	BMIZ, Chi-square, p-value Risk of overweight (BMI ≥85th percentile):	4.54 (p>0.05) 4.98 (p>0.05)
Carlson, 2012[24] PCS USA	Analytic N: 254 Baseline age: 6-7y 48% Latino	Breakfast with family (d/wk) Assessed at baseline using a single question	BMIZ over 2y, β (95% CI), p-value Breakfast with family:	 **-0.04 (-0.07, 0.00), p<0.05**

	Ovwt/Ob: 35%		% body fat over 2y, β (95% CI), p-value Breakfast with family:	 -0.35 (-0.69, -0.02), p<0.05
Gingras, 2018[30] PCS USA	Analytic N: 995 Age 4y at baseline Predominantly high SES BMIZ (Mean±SD): Males: 0.34±1.06; Females: 0.39±1.06	Eating breakfast daily vs breakfast skipping ≤6 d/wk Assessed repeatedly from ages 4-10y using single question on average frequency over the past month	BMIZ [β (95% CI)] at 13y (SD 0.9) • Daily breakfast: Males (n=502) • Daily breakfast: Females (n=489)	 **-0.13 (-0.24, -0.02)** **-0.13 (-0.23, -0.02)**
			Waist circumference [β (95% CI), cm] at 13.2y (SD 0.9) • Daily breakfast: Males (n=504) • Daily breakfast: Females (n=491)	 -0.60 (-1.87, 0.68) **-1.59 (-2.67, -0.51)**
			%FM [β (95% CI), %] at 13.2y (SD 0.9) • Daily breakfast: Males (n=355) • Daily breakfast: Females (n=366)	 **-1.43 (-2.42, -0.45)** **-1.47 (-2.25, -0.68)**
			Trunk fat mass [β (95% CI), kg] at 13.2y (SD 0.9) • Daily breakfast: Males (n=355) • Daily breakfast: Females (n=366)	 -0.40 (-0.88, 0.08) **-0.92 (-1.33, -0.51)**
			Trunk:peripheral fat [β (95% CI)] at 13.2y (SD 0.9) • Daily breakfast: Males (n=355) • Daily breakfast: Females (n=366)	 **-0.02 (-0.03, -0.01)** **-0.05 (-0.06, -0.03)**
Kelly, 2016[35] PCS UK	Analytic N: 16,936 Baseline age: 5y BMI: 16.4±1.9 kg/m^2 Breakfast skipping: 8%	"Regularly skipping" breakfast vs. eating breakfast Assessed at baseline using single, yes/no question	BMI trajectory across ages 3-11y, OR (95% CI), p-value • Decreasing BMI trajectory: • Moderate increasing BMI trajectory: • High increasing BMI trajectory:	 **2.01 (1.03, 3.92), p<0.05** **1.66 (1.37, 2.02), p<0.001** **1.76 (1.21, 2.56), p<0.01**

Kesztyus, 2017[36] PCS, Baden Württemberg Study Germany	Analytic N: 1,733 Age: 7y Ovwt/Ob: 13% Maternal or Paternal Ovwt/Ob: 71%	Breakfast skippers (rarely or never) vs. eaters (often or always) Evaluated at baseline as part of a multi-component, school-based health promotion program	Abdominal obesity at 1y follow up, OR (95% CI) • Complete breakfast data (n=1,538) • Missing breakfast data imputed (n=1,733)	 **3.68 (1.85, 7.33)** **3.03 (1.59, 5.79)**
Kesztyus, 2016[37] PCS, Baden Württemberg Study Germany	Analytic N: 1,545 Baseline age: 7y Ovwt/Ob: 13% Maternal or Paternal Ovwt/Ob: 71%	Skipping breakfast before school (eating breakfast 'never' or 'rarely') vs. eating breakfast before school 'often' or 'always' Evaluated at baseline as part of a multi-component, school-based health promotion program	Change in waist to height ratio over 1y follow up, β±SE, p-value • Skipping vs. eating: • Skipping vs. eating (adjusting for school-level clustering):	 **0.39±0.19, p<0.05** 0.36±0.19, p>0.05
MacFarlane, 2009[43] PCS Australia	Analytic N: 293 Baseline age: Younger cohort (5-6y); *Older cohort (10-12y) data in table below* Ovwt/Ob: 19% Breakfast skipping: 9%	Breakfast skipping (less than daily breakfast intake) vs. daily breakfast intake at home over the past few months Assessed at baseline by a single question	BMIZ at 3y follow up, β (95% CI) • Younger cohort (n=161): Ovwt/Ob at 3y follow up, OR (95% CI) • Younger cohort (n=161):	 0.3 (-0.2, 0.7) 1.2 (0.3, 4.4)
Miller, 2011[45] PCS USA	Analytic N: ~11,400 Baseline age: 6y Free school lunch: 29% BMI: NR Mean breakfast with family (past wk): 4.6 Mean school breakfast (past 5 d): 0.9	Frequency of breakfast with family (typical wk) or school breakfast (typical 5-day school wk) Assessed at baseline using 2 separate questions	BMI rate of change over 5y follow up, β, p-value • Breakfast with family: • School breakfast:	 **-0.01, p<0.001** **0.01, p<0.01**
Okada, 2018[47] PCS	Analytic N: 43,663 Baseline age: 7y	Breakfast skipping (skipping usually or sometimes) vs. normally eating breakfast	Prevalence of ovwt/ob (≥95th percentile) at annual follow ups (ages 8, 9, 10, and 11y), OR (95% CI) Breakfast skipping at age 7y:	 **Age 8: 1.46 (1.22, 1.75); Age 9: 1.58 (1.33, 1.88);**

Japan	Nationally representative sample BMI (parent report): NR	Assessed repeatedly from age 7-11y		**Age 10: 1.52 (1.28, 1.81); Age 11: 1.54 (1.28, 1.84); Age 12: 1.67 (1.39, 2.00)**
			Breakfast skipping at age 8y:	**Age 9: 1.57 (1.32, 1.86); Age 10: 1.56 (1.31, 1.85); Age 11: 1.80 (1.52, 2.14); Age 12: 1.84 (1.55, 2.19)**
			Breakfast skipping at age 9y:	**Age 10: 2.04 (1.47, 2.82); Age 11: 2.16 (1.55, 2.99); Age 12: 1.94 (1.36, 2.76)**
			Breakfast skipping at age 10y:	**Age 11: 1.80 (1.29, 2.50); Age 12: 1.49 (1.04, 2.13)**
			Breakfast skipping at age 11y:	**Age 12: 1.51 (1.19, 1.92)**
Shang, 2020[49] PCS China	Analytic N: 6,964 Baseline age: 9y (Range 6-13y) >80% both parents with <13y education BMI: ~17.0 kg/m^2 Breakfast frequency at 6-13y: 2.2% 0 d/wk, 14.0% 1-6 d/wk, 83.8% 7 d/wk	Breakfast frequency at age 6-13y; classified as 0, 1-6, and 7 d/wk Assessed at baseline using single question	Δ BMIZ [kg/m^2 (SE)] from baseline to 1y follow-up Breakfast 0 (n=137) vs 1-6 (n=900) vs 7 (n=5,327) d/wk:	0.14 (0.05) vs 0.11 (0.02) vs 0.11 (0.01), p(trend)= 0.48
			Δ Waist circumference [cm (SE)] from baseline to 1y follow-up at 6-13y: Breakfast 0 (n=137) vs 1-6 (n=904) vs 7 (n=5323) d/wk:	0.24 (0.04) vs 0.20 (0.02) vs 0.20 (0.01)), p(trend)= 0.53
			Δ %FM [% (SE)] from baseline to 1y follow-up at 6-13y: Breakfast 0 (n=129) vs 1-6 (n=864) vs 7 (n=5196) d/wk:	0.29 (0.07) vs 0.22 (0.03) vs 0.23 (0.03), p(trend)= 0.63

Thompson, 2006[52] PCS USA	Analytic N: 101 Baseline age: Median: 9y (Range: 8-12y) Female: 100% White: 74% SES: Parental income: <$50K: 40% BMI ≥85th percentile: 4%; TSF <85th percentile: 100%	EI 6:00-10:59AM as a percentage of TEI, successfully Assessed using 7-day dietary records at baseline and at least 1 other time point across 10y follow up	Δ BMIZ from baseline to ~6y follow up (Median: 6y, Range: 2-10y), R, r^2, F-value, p-value • Weekday mornings: • Weekend mornings: • Weekday + weekend mornings:	 R: -0.46, r^2: 0.61, F: 0.57, P > 0.05 R: -0.22, r^2: 0.55, F: 0.17, P > 0.05 R: -0.65, r^2: 0.73, F: 0.80, P > 0.05
Tin, 2011[54] PCS Hong Kong	Analytic N: 68,606 Baseline age: 9-10y SES: ≤secondary school education: 90% Ovwt/Ob: ~23% Breakfast skipping: 5%	Breakfast skipping ("no breakfast at all") vs. breakfast eating Assessed at baseline using a single question	Δ BMI from baseline to 2y follow up, β (95% CI), p-value • Breakfast skipping *Results stratified by lunch habit and TV viewing habit are available in paper*	 **0.11 (0.07, 0.16), p<0.001**
Tin, 2012[55] PCS Hong Kong	Analytic N: 68,606 Baseline age: 9-10y SES: ≤secondary school education: 90% Ovwt/Ob: ~23% Breakfast skipping: 5%	Eating breakfast at home vs. eating breakfast away from home or skipping breakfast Assessed at baseline using a single question	Δ BMI from baseline to 2y follow up, β (95% CI), p-value • Eating at home (REF): • Eating away from home: • Skipping breakfast:	 **0.15, 95% CI: 0.11, 0.18, p < 0.001** **0.13, 95% CI: 0.09, 0.18, p < 0.001**
		Consistent breakfast habits at baseline and 2y follow up	Δ BMI from baseline to 2y follow up, β (95% CI), p-value • Eating at home at both time points (REF): • Eating away from home at both time points: • Skipping breakfast at both time points:	 **0.21, 95% CI: 0.16, 0.26, p < 0.001** **0.18, 95% CI: 0.11, 0.24, p < 0.001**
		Eating breakfast at home at both time points VS. change in breakfast habits across 2 y	Breakfast at home at both time points (REF) • At home at baseline but away from home at follow up • At home at baseline but skipped at follow up	 **0.19, 95% CI: 0.15, 0.23, P < 0.001** **0.18, 95% CI: 0.14, 0.23, p < 0.001**

			• Away from home at baseline but at home at follow up	**0.11 (95% CI: 0.07, 0.16), p < 0.001**
			• Away from home at both time points	**0.21 (95% CI: 0.16, 0.26), p < 0.001**
			• Away from home at baseline and skip at follow up	**0.28 (95% CI: 0.19, 0.37), p < 0.001**
			• Skip at both time points	**0.17 (95% CI: 0.11, 0.24), p < 0.001**
			• Skip at baseline but eat at home at follow up	**0.08 (95% CI: 0.02, 0.15), p = 0.014**
			• Skip at baseline but eat away from home at follow up	**0.33 (95% CI: 0.22, 0.45), p < 0.001**
Traub, 2018[56] PCS, Baden Württemberg Study Germany	Analytic N: 1,545 Baseline age: 7y Ovwt/Ob: 13% Maternal or Paternal Ovwt/Ob: 71% Breakfast skipping: 13%	Skipping breakfast (eating breakfast 'never' or 'rarely') vs. eating breakfast 'often' or 'always' Evaluated at baseline as part of a multi-component, school-based health promotion program	Δ Waist-to-height ratio (≥0.5 = obesity) from baseline to 1y follow up, β±SE, p-value • Skipping breakfast	 **0.50±0.19, p<0.01**
			Δ BMI percentile from baseline to 1y follow up, β±SE, p-value • Skipping breakfast	 **2.01±0.90 (p<0.05)**

[a] Abbreviations: ANCOVA: analysis of covariance; CI: confidence interval; d: days; FM: fat mass; ITT: intention-to-treat analysis; NR: not reported; NRCT: non-randomized controlled trial; NS: nonsignificant; OR: odds ratio; Ob: obese; Ovwt: overweight; PCS: prospective cohort study; PP: per-protocol analysis; RCT: randomized controlled trial; ref: reference group; SD: standard deviation; SE: standard error; SES: socioeconomic status; TEI: total energy intake; wk: week; y: year(s)

Table 16. Risk of bias for observational studies examining breakfast intake in childhood (5-9 years) and weight-related outcomes[a]

Article	**Confounding** (Key confounders: age, sex, SES, race/ethnicity, physical activity, baseline BMI, parental BMI, TEI)	Selection of participants	Classification of exposures	Deviations from intended exposures	Missing data	Outcome measurement	Selection of the reported result
Affenito[21]	**SERIOUS** Key confounders not accounted for: parental BMI	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**MODERATE** No pre-registered protocol
Albertson[22]	**SERIOUS** Key confounders not accounted for: parental BMI	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**MODERATE** No pre-registered protocol
Barton [23]	**SERIOUS** Key confounders not accounted for: parental BMI	**LOW**	**LOW**	**LOW**	**MODERATE** No information on adjustment for or proportion of missing data across groups	**LOW**	**MODERATE** No pre-registered protocol
Carlson[24]	**SERIOUS** Key confounders not accounted for: parental BMI, TEI	**LOW**	**LOW**	**MODERATE** Measured at baseline only	**LOW**	**LOW**	**MODERATE** No pre-registered protocol
Gingras[30]	**SERIOUS** Key confounders not accounted for: physical activity, TEI	**LOW**	**LOW**	**LOW**	**SERIOUS** No adjustment for missing data or information on missing data across groups	**LOW**	**MODERATE** No pre-registered protocol
Kelly[35]	**MODERATE** Key confounders not accounted for: None	**LOW**	**MODERATE** Unclear exposure definition and measurement technique & validity	**MODERATE** Measured at baseline only	**LOW**	**LOW**	**MODERATE** No pre-registered protocol
Kesztyus, 2017[36]	**SERIOUS**	**LOW**	**MODERATE** Inadequate description of the type and validity	**MODERATE**	**MODERATE**	**LOW**	**MODERATE** Analyses not detailed in

	Key confounders not accounted for: SES, physical activity, parental BMI, TEI		of exposure assessment tool	Measured at baseline only	Proportion of missing data varied by exposure level		pre-registered protocol
Kesztyus, 2016[37]	**SERIOUS** Key confounders not accounted for: TEI	**LOW**	**MODERATE** Inadequate description of the type and validity of exposure assessment tool	**MODERATE** Measured at baseline only	**MODERATE** Proportion of missing data varied by exposure level	**LOW**	**MODERATE** Analyses not detailed in pre-registered protocol
MacFarlane[43]	**SERIOUS** Key confounders not accounted for: TEI	**LOW**	**LOW**	**MODERATE** Measured at baseline only	**SERIOUS** Unbalanced missingness across group without adjustment	**LOW**	**MODERATE** No pre-registered protocol
Miller[45]	**SERIOUS** Key confounders not accounted for: Parental BMI, TEI	**LOW**	**LOW**	**MODERATE** Measured at baseline only	**SERIOUS** Participants excluded for missing data; missingness unbalanced across groups; inadequate statistical adjustment	**LOW**	**MODERATE** No pre-registered protocol
Okada[47]	**SERIOUS** Key confounders not accounted for: race/ethnicity, physical activity, parental BMI, TEI	**LOW**	**MODERATE** Unclear question wording; no info on validity	**LOW**	**SERIOUS** Unclear if amount of missingness varied across groups; no info on statistical adjustment	**MODERATE** Parent report	**MODERATE** No pre-registered protocol
Shang[49]	**SERIOUS** Key confounders not accounted for: SES	**LOW**	**LOW**	**MODERATE** Measured at baseline only	**MODERATE** Participants with missing data varied from those without and were excluded	**LOW**	**MODERATE** No pre-registered protocol
Thompson[52]	**SERIOUS** Key confounders not accounted for: TEI	**MODERATE** Health-based inclusion criteria related to outcome	**LOW**	**LOW**	**SERIOUS** Participants excluded for missing data; no info on how missingness varied across groups; inadequate statistical adjustment	**LOW**	**MODERATE** No pre-registered protocol

Tin, 2012[55]	**SERIOUS** Key confounders not accounted for: race/ethnicity, physical activity, parental BMI, TEI	**LOW**	**LOW**	**MODERATE** Measured at baseline only	**MODERATE** Unclear how participants were excluded for missing data	**LOW**	**MODERATE** No pre-registered protocol
Tin, 2011[54]	**SERIOUS** Key confounders not accounted for: race/ethnicity, parental BMI, TEI	**LOW**	**LOW**	**MODERATE** Measured at baseline only	**MODERATE** Unclear how participants were excluded for missing data	**LOW**	**MODERATE** No pre-registered protocol
Traub[56]	**SERIOUS** Key confounders not accounted for: physical activity, baseline BMI, parental BMI	**LOW**	**MODERATE** Inadequate description of the type and validity of exposure assessment tool	**MODERATE** Measured at baseline only	**MODERATE** Proportion of missing data varied by exposure level	**LOW**	**MODERATE** Analyses not detailed in pre-registered protocol

[a] Possible ratings of low, moderate, serious, critical, or no information determined using the "Risk of Bias for Nutrition Observational Studies" tool (RoB-NObs) (Dietary Guidelines Advisory Committee. 2020. *Scientific Report of the 2020 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Agriculture and the Secretary of Health and Human Services*. U.S. Department of Agriculture, Agricultural Research Service, Washington, DC.)

Table 17: Evidence examining the relationship between breakfast intake in early adolescence (10-12 years) and weight-related outcomes[a]

Study	Notable participant characteristics	Intervention and comparator	Outcomes	Results
Cayres, 2018[25] PCS Brazil	Analytic N: 86 Baseline age: 11y (Range 11-14y) High breakfast skipping (≤6d/wk): 57% BMI: breakfast skippers: 22.1 kg/m^2; breakfast eaters: 19.8 kg/m^2	Higher vs. lower frequency of breakfast intake (0, 1-2, 3-5, 7 d/wk) Assessed using a single question and summed baseline and 1-yr follow up	Δ Whole body fatness, SEM with physical activity as mediator, r (95% CI) • Breakfast intake:	 **-0.27 (-0.50, -0.05)**
			Δ Whole body fatness, SEM r (95% CI) • Breakfast intake:	 **-0.27 (-0.46, -0.06)**
			Δ Trunk fatness, SEM with physical activity as mediator • Breakfast intake:	 -0.22 (-0.46, 0.01)
			Δ Trunk fatness, SEM r (95% CI) • Breakfast intake:	 **-0.23 (-0.42, -0.02)**
Chang, 2013[26] PCS USA	Analytic N: 6,220 Baseline age range: 10-12y BMI: NR	Breakfast with family (d/wk) Assessed at baseline only by a single question	Δ Weight status over 3y, OR (95% CI) • Ob/ovwt to healthy vs. stable ob: • Ovwt to healthy vs. stable ovwt: • Ovwt to obese vs. stable ovwt: • Healthy to ovwt/ob vs. stable healthy:	 1.00 (0.98, 1.01) 1.02 (1.00, 1.03) 1.01 (0.99, 1.02) 1.00 (0.99, 1.00)
Elgar, 2005[29] PCS (cluster) UK	Analytic N: 355 (20 schools) Baseline age range: 11-14y Ovwt/ob: 20%	Frequency of breakfast skipping during a typical week Assessed at baseline only	BMI at 4-yr follow up, β±SE (p-value) • Breakfast skipping:	 0.13 (p<0.05)
			BMI change across 4 years, β±SE (p-value)	

			• Breakfast skipping	0.02 (p=NS)
Goff, 2019[31] PCS UK	Analytic N: 665 Baseline age: 11-13y 20% Black African, 17% Bangladeshi/Pakistani, 16% White British, 15% Black Caribbean, 15% Indian, 17% Other Ovwt/Ob: 39%	Any breakfast skipping vs. breakfast every day at age 11-13y Assessed by a single question at baseline	BMI at 21-23y (N=664), β (95% CI), p-value • Skipping breakfast at 11-13y:	 **1.41 (0.57, 2.26), p<0.001**
			Waist:height ratio (N=635), β (95% CI), p-value • Skipping breakfast at 11-13y:	 **0.02 (0.01, 0.03), p<0.001**
Haerens, 2010[32] PCS Belgium	Analytic N: 585-1066, depending on time point Baseline age: 10y BMI (self-report): NR	Frequency of breakfast intake (d/wk), continuous Assessed by a single item annually across 4 years	BMIZ across 4y follow up, β±SE, p-value • Baseline breakfast intake: • Change in breakfast intake across 4y follow-up:	 **-0.04±0.01 (p<0.01)** -0.03±0.02 (p>0.05)

Hassan, 2019[34]
PCS
Brazil
	Analytic N: 809
	Baseline age: 10-16y
	White: 46%
	Ovwt/ob: 42%
		Breakfast frequency at 10-16y (baseline) (never or almost never: 'none'; 1-4x/wk: 'intermediate'; 5-7x/wk: 'regular')
		Change in breakfast with family frequency over 3y follow up (≥5 d/wk: regular; <5 d/wk: irregular)
			BMIZ trajectory across 1y, 2y, and 3y follow up:
			• Baseline breakfast frequency (10-16y, n=809):
			  ○ Males:
			  ○ Females:
			• 3-year persistence of breakfast frequency (n=488):
			  ○ Males:
			  ○ Females:
				
				NS
				NS
				
				NR
				NR

			%BF trajectory across 1y, 2y, and 3y follow up:
			• Baseline breakfast frequency (10-16y, n=809):
			  ○ Males:
			  ○ Females:
			• 3-year persistence of breakfast frequency (n=488):
			  ○ Males:
				
				NS
				Smaller increase in %BF over 3y in intermediate breakfast consumers vs. regular consumers (p<0.05)
				
				NS

			○ Females:	**Smaller increase in %BF in persistently intermediate breakfast consumers vs. persistently regular consumers (p<0.05)**
		Breakfast with family frequency at 10-16y (baseline) (never or almost never: ‘none’; 1-4x/wk: ‘intermediate’; 5-7x/wk: ‘regular’) Change in breakfast with family frequency over 3y follow up (≥5 d/wk: regular; <5 d/wk: irregular)	BMIZ trajectory across 1y, 2y, and 3y follow up: • Baseline breakfast with family frequency (10-16y, n=809): ○ Males & Females	NS
			• 3-year persistence of breakfast with family frequency (n=488): ○ Males & Females	NR
			%BF trajectory across 1y, 2y, and 3y follow up: • Baseline breakfast with family frequency (10-16y, n=809): ○ Males:	NS
			○ Females:	**Smaller increase in %BF over 3y in persistently intermediate breakfast with family consumers vs. persistently regular consumers (p<0.05)**
			• 3-year persistence of breakfast with family frequency (n=488): ○ Males:	**Larger decrease in %BF in those whose family breakfast frequency changed over 3y vs. those who regularly ate with family at both time points (p<0.05)**
			○ Females:	NS
MacFarlane, 2009[43]	Analytic N: 293	Breakfast skipping (less than daily breakfast intake)	BMIZ at 3y follow up, β (95% CI)	

PCS Australia	Baseline age: Older cohort (10-12y); *Younger cohort (5-6y-data in previous table*) Ovwt/Ob: 21% Breakfast skipping: 8%	vs. daily breakfast intake at home over the past few months Assessed at baseline by a single question	• Older cohort (n=132): Ovwt/Ob at 3y follow up, OR (95% CI) • Older cohort (n=132):	0.3 (-0.3, 0.9) **2.2 (1.1, 4.7)**
Smith, K. 2010[50] PCS Australia	Analytic N: 1,723 Baseline age range: 9-15y SES: Low or Medium low: 45% Breakfast intake in childhood: 86%, adulthood: 73%, and both: 62% Ovwt/Ob: 9%	Breakfast skipping in childhood (9-15y) or both childhood and adulthood (26-36y) vs. eating breakfast at both time points Breakfast in childhood: eating something before school In adulthood: eating a snack, small, or large meal 6-9AM	BMI (kg/m^2) at 21y follow up (26-36y), β (95% CI) Breakfast skipping as a: • Neither • Child (n=167-178): • Both (n=69-72):	 REF **0.86 (0.04, 1.69)** **1.68 (0.41, 2.95)**
			Waist circumference at follow up (26-36y), β (95% CI) Breakfast skipping as a: • Child (n=167-178): • Both (n=69-72):	 1.55 (-0.33, 3.42) **4.63 (1.72, 7.53)**
Sudharsanan, 2016[51] PCS USA	Analytic N: 6,495 Baseline age: 9-13y, mean ~11y Below federal poverty line: 20% Race/ethnicity: White: 59%; Hispanic: 18%; Black: 16% School breakfast ≥1x/wk: 17% Family breakfast frequency: ~3.5x/wk	School breakfast (≥1x/wk) vs. no school breakfast Assessed at baseline using a single question	Obesity (≥95th percentile) at 3y follow up, OR (95% CI) • Any vs. no school breakfast (REF) at baseline:	 1.31 (0.92, 1.87) *Analyses stratified by SES quintile and poverty line available in paper*

	Obesity (≥95th percentile): 12%			
		Change in school breakfast between 5th and 8th grades vs. no change	Change in Obesity status over 3y, OR (95% CI)	0.72 (0.39, 1.31) *Analyses stratified by SES quintile and poverty line available in paper*
		Higher vs. lower frequency of family breakfast	Change in Obesity status over 3y, OR (95% CI)	0.92 (95% CI: 0.84, 1.01) *Analyses stratified by SES quintile and poverty line available in paper*
Wang, 2017[57] PCS USA	Analytic N: 468-553 depending on time point Baseline age: 5th grade Hispanic: 47%, Non-Hispanic black: 36%, Non-Hispanic white: 17% Ovwt/Ob: 53% Breakfast skipping: ~32%	Breakfast skippers (skip 4-7 d/wk) Inconsistent school eaters (eat 1-5 d/wk) Inconsistent home eaters (eat 1-5 d/wk) Regular home eaters (eat 6-7 d/wk) Regular school eaters (eat 6-7 d/wk) vs. double breakfast eaters (100% ate at home and school the previous day) Assessed at baseline only using a frequency question and a location question	Odds of having ovwt/ob over 2y follow up, OR (95% CI) • Double breakfast eaters (10%) (REF) • Breakfast skippers (12%): • Inconsistent school eaters (7%): • Inconsistent home eaters (16%): • Regular home eaters (44%): • Regular school eaters (12%):	 **2.66 (1.67, 4.24)** **2.11 (1.29, 3.46)** **2.02 (1.27, 3.21)** **1.70 (1.13, 2.56)** NR

[a] Abbreviations: ANCOVA: analysis of covariance; CI: confidence interval; d: days; FM: fat mass; ITT: intention-to-treat analysis; NR: not reported; NRCT: non-randomized controlled trial; NS: nonsignificant; OR: odds ratio; Ob: obese; Ovwt: overweight; PCS: prospective cohort study; PP: per-protocol analysis; RCT: randomized controlled trial; ref: reference group; SD: standard deviation; SE: standard error; SES: socioeconomic status; TEI: total energy intake; wk: week; y: year(s)

Table 18. Risk of bias for observational studies examining breakfast intake in early adolescence (10-12 years) and weight-related outcomes[a]

Article	**Confounding** (Key confounders: age, sex, SES, race/ethnicity, physical activity, baseline BMI, parental BMI, TEI)	Selection of participants	Classification of exposures	Deviations from intended exposures	Missing data	Outcome measurement	Selection of the reported result
Cayres[25]	**SERIOUS** Key confounders not accounted for: race/ethnicity, baseline BMI, parental BMI, TEI	**LOW**	**MODERATE** No exposure definition or info on validity	**LOW**	**SERIOUS** No info on missingness across groups; inadequate statistical adjustment	**LOW**	**MODERATE** No pre-registered protocol
Chang[26]	**SERIOUS** Key confounders not accounted for: physical activity, TEI	**LOW**	**MODERATE** Unclear assessment technique; no info on validity	**MODERATE** Measured at baseline only	**SERIOUS** Unclear if missingness resulted in exclusion, was balanced across groups, or was adjusted for statistically	**LOW**	**MODERATE** No pre-registered protocol
Elgar[29]	**SERIOUS** Key confounders not accounted for: race/ethnicity, parental BMI, TEI	**LOW**	**MODERATE** Unclear exposure definition	**MODERATE** Measured at baseline only	**CRITICAL** High attrition (46%) with inadequate statistical adjustment	**LOW**	**MODERATE** No pre-registered protocol
Goff[31]	**SERIOUS** Key confounders not accounted for: parental BMI	**LOW**	**LOW**	**MODERATE** Measured at baseline only	**MODERATE** Inadequte adjustment for missing data; no information on missing data across groups	**LOW**	**MODERATE** No pre-registered protocol
Haerens[32]	**SERIOUS** Key confounders not accounted for: race/ethnicity, baseline BMI, parental BMI, TEI	**LOW**	**LOW**	**LOW**	**SERIOUS** Unequal proportion of missingness across groups; inadequate statistical adjustment	**SERIOUS** Self-report	**MODERATE** No pre-registered protocol
Hassan[34]	**SERIOUS**	**LOW**	**LOW**	**LOW**	**MODERATE**	**LOW**	**MODERATE** No pre-registered protocol

	Key confounders not accounted for: race/ethnicity, SES, parental BMI, TEI				High attrition (40%) with no information on proportions across groups		
MacFarlane[43]	**SERIOUS** Key confounders not accounted for: TEI	**LOW**	**LOW**	**MODERATE** Measured at baseline only	**SERIOUS** Unbalanced missingness across groups without adjustment	**LOW**	**MODERATE** No pre-registered protocol
Smith[50]	**SERIOUS** Key confounders not accounted for: race/ethnicity, physical activity, parental BMI	**LOW**	**LOW**	**LOW**	**SERIOUS** No info on proportion of missingness across groups; inadequate statistical adjustment	**LOW**	**MODERATE** No pre-registered protocol
Sudharsanan[51]	**SERIOUS** Key confounders not accounted for: parental BMI, TEI	**LOW**	**LOW**	**MODERATE** Measured at baseline only	**SERIOUS** No info on proportion of missingness across groups; inadequate statistical adjustment	**LOW**	**MODERATE** No pre-registered protocol
Wang[57]	**SERIOUS** Key confounders not accounted for: SES, race/ethnicity, physical activity, parental BMI, TEI	**LOW**	**LOW**	**MODERATE** Measured at baseline only	**MODERATE** Inadequate statistical adjustment for missing data	**LOW**	**MODERATE** No pre-registered protocol

[a] Possible ratings of low, moderate, serious, critical, or no information determined using the "Risk of Bias for Nutrition Observational Studies" tool (RoB-NObs) (Dietary Guidelines Advisory Committee. 2020. *Scientific Report of the 2020 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Agriculture and the Secretary of Health and Human Services*. U.S. Department of Agriculture, Agricultural Research Service, Washington, DC.)

Table 19: Evidence examining the relationship between breakfast intake in later adolescence (13+ years) and weight-related outcomes[a]

Study	Notable participant characteristics	Intervention and comparator	Outcomes	Results
Kim, 2021[38] RCT (parallel) Korea	Analytic N: 105 (ITT) Baseline age: 15y (Range 12-18y) 100% Habitual breakfast intake <3 d/wk BMI: ~25 kg/m^2	3 breakfast arms: Rice-based (n=35) vs. wheat-based (n=35) vs. usual intake control (n=35) weekdays for 12 wk	Δ Obesity rate, Chi-square, p-value Across arms at 12 wk follow up:	 0.41 (x^2=8.93)
			Δ %FM, ANCOVA, Mean±SD, p-value Across arms at 12 wk follow up:	 **Rice: -0.2±3.4; Wheat: 0.1±2.4; Control: -0.3±2.1, (p=0.03)**
			Δ Waist:hip ratio, ANCOVA, Mean±SD, p-value Across arms at 12 wk follow up:	 Rice: 0.02±0.03; Wheat: 0.02±0.03; Control: 0.00±0.04; (p=0.98)
Crossman, 2006[27] PCS, Add Health USA	Analytic N: 6,378 Baseline age: 15y (Range 12-20y) 59% White, 21% Black, 15% Hispanic, 10% Native American, 7% Asian Ovwt/Ob (self-report): 22% Breakfast skipping: 19%	Breakfast skippers vs. breakfast eaters Assessed at baseline only using a single, Y/N question	BMI at 6y follow up (18-26y), OR, p-value • Males: • Females:	 **1.37, p<0.05** 1.23, p>0.05
De Winter, 2016[28] PCS The Netherlands	Analytic N: 1,816 Baseline age: ~13y Breakfast skipping: 23% Ovwt/Ob: 9%	Breakfast skipping vs. regular breakfast eating (≥5 d/wk) Assessed using a single item at multiple time points but only baseline data used	Incidence ovwt/ob 1-4y after baseline, OR (95% CI) • Breakfast skipping:	 1.41 (0.97, 2.06)

Haines, 2007[33] PCS, Project EAT USA	Analytic N: 2,516 Baseline age: 13-16y White: 48%; Black: 19%; Asian: 20%; Hispanic: 6%; Native American: 4% Low or middle SES: 37% Ovwt/Ob (self-report): 26% Breakfast intake (times/wk): Females: 3.5; Males: 4.3	Frequency of breakfast intake over past wk Assessed using a single question at baseline and 5-year follow up	Prevalence of ovwt (>85th percentile) at 5y follow up, OR (95% CI) • Females (n=1,380): • Males (n=1,119):	 **0.89 (0.83, 0.97)** **0.89 (0.82, 0.97)**
		Increase in frequency of breakfast intake from baseline to 5y follow up:	Incidence ovwt (>85th percentile) in those normal weight at baseline, OR (95% CI): • Females (n=964): • Males (n=785):	 **0.84 (0.74, 0.96)** **0.84 (0.74, 0.96)**
Laska, 2012[39] PCS USA	Analytic N: 562 Baseline age: ~15y (grade range 6-11th) White: 87% Free/reduced price lunch eligible: ~11% BMI: males: 22.1±5.08; females: 21.9±4.91 Breakfast intake (meals/d): Males: 0.91, Females: 0.88	Percent of 3 recall days containing a meal called 'breakfast' that was ≥50 kcal Assessed at baseline and 2y follow up using 3, 24-hr dietary recalls	BMI at 2y follow up, β±SE, p-value Males: • TEI adjusted: • TEI not adjusted: Females: • TEI adjusted: • TEI not adjusted:	 -0.21±0.48, p=0.65 -0.19±0.48, p=0.69 -0.31±0.45, p=0.49 -0.26±0.46, p=0.57
			% Body fat at 2y follow up, β±SE, p-value Males: • TEI adjusted: • TEI not adjusted: Females:	 -1.80±1.23, p=0.14 -1.47±1.27, p=0.25

			• TEI adjusted:	-0.38±0.86, p=0.66
			• TEI not adjusted:	-0.18±0.86, p=0.83
Lee, 2009[40] PCS, Add Health USA	Analytic N: 9,730 Baseline age: ~15y (range 12-19y) Low SES: >60% White: 69%, Black: 15%, Hispanic 11% BMI (self-report): NR Parental obesity: 22% Breakfast skipping 6-7x/wk: Females: 13%; Males: 9%	Breakfast skipping (baseline: usually eating nothing for breakfast; follow up: eating breakfast 0-2x in past wk) vs. eating breakfast ≥3x/wk Assessed using a single item at baseline only	Obesity incidence at ~6y follow up, OR±SE, p-value	
			• Females:	0.20±0.15, p>0.05
			• Males:	**0.63±0.18, p<0.01**
			Obesity persistence at ~6y follow up, OR±SE, p-value	
			• Females:	**0.60±0.20, p<0.01**
			• Males:	**0.87±0.20, p<0.001**
Liechty, 2015[41] PCS, Add Health USA	Analytic N: 13,568 Baseline age: 16y Parent education: 46% high school or less White: 65%, Black, 16%, Hispanic 12% Ovwt/Ob (self-report): males: 22%; females: 27% Breakfast skipping: Females: 22%; Males: 16%	Breakfast skipping vs. eating breakfast (only measured weekdays) Assessed using a single item at baseline only	Overweight incidence at 1y follow up, RR (95% CI), p-value	
			Male:	
			• Not adjusted for BMIZ:	1.00 (0.63, 1.13), p=0.99
			• Adjusted for BMIZ:	0.78 (0.49, 1.24), p=0.30
			Female:	
			• Not adjusted for BMIZ:	**1.60 (1.13, 2.28), p=0.009**
			• Adjusted for BMIZ:	**1.44 (1.00, 2.07), p=0.048**
			Obesity incidence at 1y follow up, RR (95% CI), p-value	
			Male:	
			• Not adjusted for BMIZ:	**1.80 (1.11, 2.91), p=0.02**
			• Adjusted for BMIZ:	1.39 (0.87, 2.21), p=0.17
			Female:	
			• Not adjusted for BMIZ:	1.14 (0.79, 1.64), p=0.48
				0.73 (0.47, 1.13), p=0.16

			• Adjusted for BMIZ:	
Lipsky, 2015[42] PCS USA	Analytic N: 2,785 Baseline age: 16y White: 56%, Black: 20%, Hispanic 19% Family affluence: 5.4 (0-7 scale where 7 is 'high') Ovwt/Ob (self-report): 39%	Higher vs. lower frequency of breakfast intake (more than a glass of milk or fruit juice) across 4y follow up Assessed using a single item annually across 4y	Δ BMI across 4y follow up, β±SE, p-value	
			• Higher vs. lower frequency of breakfast intake	-0.05±0.05, p=0.25
Merten, 2009[44] PCS, Add Health USA	Analytic N: 7,788 Baseline age: 16y (range 12-19y) Below poverty: 14% Chronic obesity (self-report, adolescence and young adulthood): 12% Adolescent breakfast ≥4x/wk: 59%	Regular breakfast intake (≥4 d/wk) vs. no regular breakfast intake <4 d/wk in adolescence (Adol) and/or young adulthood (YA): Assessed using a single question at baseline (12-19y) and follow up (18-26y)	Chronic obesity (≥95th percentile in adolescence (12-19y) and >30 kg/m^2 in adulthood (18-26y)), OR (95% CI), p-value	
			• No regular breakfast (Adol only, controlling for YA breakfast habit)	**0.59 (0.52, 0.68), p<0.001**
			• Regular breakfast (Adol only) vs. regular breakfast (YA only)	0.90 (0.84, 1.02), p>0.05
			• Regular breakfast (Adol only) vs no regular breakfast (Adol & YA)	**0.69, 0.60, 0.81), p<0.001**
			• Regular breakfast (Adol & YA) vs. no regular breakfast (Adol & YA)	**0.41 (0.34, 0.48), p<0.001**
			• Regular breakfast (Adol & YA) vs. regular breakfast (Adol only)	**0.58 (0.49, 0.69), p<0.001**
Niemeier, 2006[46] PCS, Add Health USA	Analytic N: 9,919 Baseline age: 16y (age range: 11-21y) White: 66%, Black: 15%, Hispanic 12% Parent education ≤High school: 37% Ovwt/Ob: 29%	Frequency of breakfast intake (past 7 d) Assessed using a single question at baseline and 5-6y follow up	BMIZ at 5-6y follow up, β, p-value	
			• Baseline breakfast:	**-0.02, p<0.001**
			• Change in breakfast from baseline to follow up:	**-0.01, p<0.01**
Quick, 2013[48]	Analytic N: 1,643	Frequency of breakfast intake (previous wk):	Incidence of overweight (≥25 kg/m^2) at 10y follow up, OR (95% CI)	

PCS, Project EAT USA	Baseline age: 15y (range junior-senior high school) Race/ethnicity: White: 49%, Black: 17%, Asian: 18%, Hispanic: 6%; Native American: 3% SES: Low or Low-Middle: ~35% Ovwt/Ob (self-report): 26% Breakfast frequency: ~4x/wk	Assessed using a single question at baseline and 10y follow up	Baseline breakfast: • Females (n=887): • Males (n=756):	 **0.91 (0.86, 0.97)** 0.95 (0.90, 1.01)
		Change in frequency of breakfast intake from baseline to 10y follow up:	Change in breakfast intake: • Females (n=887): • Males (n=756):	 0.97 (0.91, 1.04) 1.02 (0.95, 1.09)
Timlin, 2008[53] PCS, Project EAT USA	Analytic N: 2,216 Baseline age: ~15y Ovwt/Ob (self-report): 26% Breakfasts: daily: ~33%, intermittent: ~53%, never: ~15%	Never or intermittent (1-6x/wk) vs. daily breakfast intake Assessed at baseline at 5y follow up using a single question	Δ BMI from baseline to 5y follow up, Mean±SE, p-value • Daily (n=764): • Intermittent (n=1,152): • Never (n=300):	 1.6±0.16 **2.0±0.09 (p<0.05)** **2.2±0.19 (p<0.05)**
Wennberg, 2015[58] PCS Sweden	Analytic N: 889 Baseline age: 16y Low SES: ~39% BMI: ~19.5 kg/m^2 Breakfast skipping or poor quality: 10%	Eating breakfast vs. skipping or eating a poor quality breakfast (i.e., only eating something sweet (e.g., bun, cookie) or drinking something energy-containing) Assessed using a single item at baseline only	Central obesity at 27y follow up (waist circumference ≥80 cm for women and ≥94 cm for men), OR (95% CI) • Poor breakfast habits	 1.71 (95% CI: 1.00, 2.92)

[a] Abbreviations: ANCOVA: analysis of covariance; CI: confidence interval; d: days; FM: fat mass; ITT: intention-to-treat analysis; NR: not reported; NRCT: non-randomized controlled trial; NS: nonsignificant; OR: odds ratio; Ob: obese; Ovwt: overweight; PCS: prospective cohort study; PP: per-protocol analysis; RCT: randomized controlled trial; ref: reference group; SD: standard deviation; SE: standard error; SES: socioeconomic status; TEI: total energy intake; wk: week; y: year(s)

Table 20. Risk of bias for randomized controlled trials examining breakfast intake in older adolescence (13+ years) and weight-related outcomes[a]

Article	Randomization	Deviations from intended interventions (effect of assignment) or (per-protocol)	Missing outcome data	Outcome measurement	Selection of the reported result
Kim, 2021[38]	**LOW**	**LOW**	**LOW**	**SOME CONCERNS** Outcome assessors aware of intervention assignment	**LOW**

[a] Possible ratings of low, some concerns, or high determined using the "Cochrane Risk-of-bias 2.0" (RoB 2.0) (August 2016 version)" (Higgins JPT, Sterne JAC, Savović J, Page MJ, Hróbjartsson A, Boutron I, Reeves B, Eldridge S. A revised tool for assessing risk of bias in randomized trials In: Chandler J, McKenzie J, Boutron I, Welch V (editors). Cochrane Methods. *Cochrane Database of Systematic Reviews* 2016, Issue 10 (Suppl 1). https://doi.org/10.1002/14651858.CD201601.)

Table 21. Risk of bias for observational studies examining breakfast intake in older adolescence (13+ years) and weight-related outcomes[a]

Article	Confounding (Key confounders: age, sex, SES, race/ethnicity, physical activity, baseline BMI, parental BMI, TEI)	Selection of participants	Classification of exposures	Deviations from intended exposures	Missing data	Outcome measurement	Selection of the reported result
Crossman[27]	**SERIOUS** Key confounders not accounted for: TEI	**LOW**	**SERIOUS** Inadequate exposure definition, measurement description and validity info	**MODERATE** Measured at baseline only	**MODERATE** Inadequate statistical adjustment	**SERIOUS** Self report	**MODERATE** No pre-registered protocol
De Winter[28]	**SERIOUS** Key confounders not accounted for: race/ethnicity, parental BMI, TEI	**LOW**	**LOW**	**MODERATE** Used only baseline intake data	**LOW**	**LOW**	**MODERATE** No pre-registered protocol
Haines[33]	**SERIOUS** Key confounders not accounted for: parental BMI	**LOW**	**LOW**	**LOW**	**LOW**	**SERIOUS** Self report	**MODERATE** No pre-registered protocol
Laska[39]	**SERIOUS** Key confounders not accounted for: parental BMI	**LOW**	**LOW**	**LOW**	**MODERATE** No info on proportion of missingness across groups but low missing data overall	**LOW**	**MODERATE** No pre-registered protocol
Lee, 2009[40]	**SERIOUS** Key confounders not accounted for: TEI	**LOW**	**LOW**	**MODERATE** Measured at baseline only	**SERIOUS** Unbalanced missingness across group without adjustment	**LOW**	**MODERATE** No pre-registered protocol
Liechty[41]	**SERIOUS**	**LOW**	**LOW**	**MODERATE** Measured at baseline only	**MODERATE** No info on proportion of missingness across	**MODERATE** Self report at follow up	**MODERATE** No pre-registered protocol

	Key confounders not accounted for: physical activity, parental BMI, TEI				groups or statistical adjustment		
Lipsky[42]	**SERIOUS** Key confounders not accounted for: parental BMI, TEI	**LOW**	**MODERATE** Inadequate exposure definition	**LOW**	**LOW**	**SERIOUS** Self report	**MODERATE** No pre-registered protocol
Merten[44]	**SERIOUS** Key confounders not accounted for: physical activity, parental BMI, TEI	**LOW**	**MODERATE** Inadequate exposure definition and info on validity	**LOW**	**MODERATE** No info on proportion of missingness across groups or statistical adjustment	**SERIOUS** Self report	**MODERATE** No pre-registered protocol
Neimeier[46]	**SERIOUS** Key confounders not accounted for: TEI	**LOW**	**MODERATE** Inadequate exposure definition and info on validity	**LOW**	**MODERATE** No info on proportion of missingness across groups or statistical adjustment	**MODERATE** Some participant self reported (~10%)	**MODERATE** No pre-registered protocol
Quick[48]	**MODERATE** Key confounders not accounted for: None	**LOW**	**MODERATE** Inadequate exposure definition and info on validity	**LOW**	**SERIOUS** No info on proportion of missingness across groups; inadequate statistical adjustment	**MODERATE** Self report, validated in subsample	**MODERATE** No pre-registered protocol
Timlin[53]	**SERIOUS** Key confounders not accounted for: Parental BMI	**LOW**	**LOW**	**LOW**	**SERIOUS** No info on proportion of missingness across groups; inadequate statistical adjustment	**MODERATE** Self report at follow up	**MODERATE** No pre-registered protocol
Wennberg[58]	**SERIOUS** Key confounders not accounted for: race/ethnicity, parental BMI, TEI	**LOW**	**MODERATE** Inadequate info on validity	**MODERATE** Measured at baseline only	**LOW**	**LOW**	**MODERATE** No pre-registered protocol

[a] Possible ratings of low, moderate, serious, critical, or no information determined using the "Risk of Bias for Nutrition Observational Studies" tool
Advisory Committee. 2020. *Scientific Report of the 2020 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Agriculture*
Human Services. U.S. Department of Agriculture, Agricultural Research Service, Washington, DC.)

Key Question 1c: What is the relationship between eating breakfast and health?

Evidence synthesis – Physiological effects of breakfast consumption

The evidence synthesized here is presented in **Table 22** and described in the results section Description of the evidence: Physiological effects of breakfast consumption.

Perceived hunger, appetite, satiety, and fullness

Across three randomized controlled trials, participants who ate breakfast reported significantly lower hunger and appetite,[7,14,59] and significantly higher satiety,[7,59] than participants who fasted. These effects were measured throughout the morning, up to 240 minutes after breakfast, and were found in participants who were a mean age of 12 and 14 years old, who were habitual breakfast consumers and skippers, and who had a range of BMI levels.

One of the studies conducted additional analyses of normal-protein and high-protein breakfast conditions.[59] Participants in both breakfast conditions reported significantly higher satiety than participants in the fasting condition. However, the study presented some evidence that a high-protein breakfast had a stronger effect on participant appetite than a normal-protein breakfast. Participants in both breakfast conditions reported significantly lower appetite at +20 and +240 minutes than participants in the fasting condition; however, the global measure across the study period (240-minute AUC) was significant for the high-protein breakfast condition, only. The effect of the macronutrient composition of a breakfast on hunger and satiety (and other) outcomes may warrant additional examination. The literature search for this rapid review did not target macronutrient composition, specifically.

These studies share a common limitation, which is the inability to blind participants to their condition. For these subjective, participant-reported outcomes, the lack of participant blinding could result in bias. And, in fact, this may have been the case in a fourth study, not included in the synthesis,[2] in which participants, who knew their condition, reported significantly different levels of hunger, satiety, and fullness at baseline. Risks of bias are summarized in **Table 23**.

Perceived mood

This section synthesizes evidence about outcomes measured following a breakfast meal. See the section Evidence synthesis: Breakfast consumption and longitudinal mental health outcomes for longitudinal outcomes.

Evidence from three of four randomized controlled trials suggests that eating breakfast, compared with fasting, results in favorable mood outcomes.[2,7,13] The fourth study did not report significant effects of breakfast versus fasting on mood outcomes.[10]

Summarizing the evidence is complicated by a few factors. First, each study assessed different mood outcomes. Second, not all mood outcomes that were assessed were favorably impacted, or favorably impacted at all time points. Mood outcomes that were *not* favorably impacted by breakfast were simply not impacted by breakfast at all; no mood outcomes were unfavorably impacted by breakfast. Third, evidence from one study[13] suggested that breakfast impacts mood outcomes differently in girls and boys; but no other studies stratified by participant sex so it's unclear if this finding holds true across different studies. Fourth, as with perceived hunger and satiety (above), a limitation of this evidence is that a lack of participant blinding could result in bias for these subjective, participant-reported outcomes, and evidence from two studies[7,10] suggested that simply being allocated to the breakfast condition did result in favorable mood outcomes. Risks of bias are summarized in **Table 23**.

Despite these complications, the evidence generally points to a favorable impact of breakfast on mood.

Glucose, triglycerides, and hormones

This section synthesizes evidence about outcomes measured following a breakfast meal. See the section Evidence synthesis: Breakfast consumption and longitudinal cardiometabolic health outcomes for longitudinal outcomes.

Across two randomized controlled trials,[2,11] participants who ate breakfast had significantly higher glucose levels throughout the morning (measured until 150 and 180 minutes after breakfast, respectively) than participants who fasted. Participants included prepubescent children (mean age of nine years) with obesity, and a predominantly female (78%) sample of adolescents (mean age of 16 years) with a normal BMI. These findings have low risk of bias, summarized in **Table 23**. One of the studies also measured triglycerides, insulin, and glucagon, and reported that triglycerides and insulin were significantly higher, and glucagon was significantly lower, in the breakfast condition than in the fasting condition.[11]

Two randomized controlled trials examined the effects of breakfast and fasting on the gastrointestinal hormones ghrelin and PYY.[11,59] While the effects were consistent in direction, they were inconsistent with regard to their statistical significance. Maffeis et al.[11] reported that participants who ate breakfast had significantly lower total ghrelin and non-significantly higher PYY than participants who fasted. On the other hand, Leidy and Racki[59] reported that participants who ate breakfast had non-significantly lower active ghrelin and significantly higher PYY than participants who fasted. The inconsistency in statistical significance may or may not be explained by differences between the studies in participant age, pubertal status, weight status, breakfast habits, or outcome measures: Maffeis et al.[11] studied prepubescent nine-year-olds with obesity (with the rationale that differences in endocrinology due to differences in pubertal status or weight status between participants may confound the findings), and assessed total (active and inactive) ghrelin, while Leidy and Racki[59] studied 14-year-olds who were habitual breakfast skippers with a normal to overweight BMI, and assessed active ghrelin.

One randomized controlled trial[11] examined the effect of breakfast or fasting on the gastrointestinal hormone GLP-1, which was higher, but not significantly, in the breakfast condition than in the fasting condition.

Resting energy expenditure and macronutrient oxidation

One randomized controlled trial[11] examined the effects of breakfast and fasting on resting energy expenditure and macronutrient oxidation. After being fed, participants in the breakfast condition had significantly higher resting energy expenditure and carbohydrate oxidation than participants in the fasting condition, and participants in the fasting condition had significantly higher lipid oxidation. Participants had similar protein oxidation. Participants were prepubescent children (mean age 9 years) with obesity. These findings have low risk of bias, summarized in **Table 23**.

Summary statement:

- Eating breakfast, compared to no breakfast, results in lower hunger, lower appetite, and higher satiety, with effects measured as long as 4 hours after breakfast. The evidence, from three randomized controlled trials, is most generalizable to early adolescence (ages 12 to 14 years), as there is no evidence from other age groups. These findings are limited because participants could not be blinded, which could have had an impact on their subjective, self-reported outcomes.
- Eating breakfast may result in favorable mood outcomes throughout the morning. However, some of the available evidence suggests that these subjective, participant-reported outcomes may have been influenced by a lack of participant blinding.

- Eating breakfast results in higher glucose levels than fasting, with effects measured as long as 3 hours after breakfast. The evidence, from two well-conducted randomized controlled trials, was consistent in 9-year-olds with obesity and a sample of predominantly female 16-year-olds with a normal BMI.
- Some studies found that eating breakfast, compared with fasting, results in higher triglycerides, insulin, PYY, resting energy expenditure, and carbohydrate oxidation, and lower glucagon, ghrelin, and lipid oxidation during the morning. However, few studies examined these outcomes, and the evidence is limited in its generalizability.

Evidence synthesis – Breakfast consumption and longitudinal cardiometabolic health outcomes

The evidence synthesized here is presented in **Table 24** and described in the results section Description of the evidence: Breakfast consumption and longitudinal cardiometabolic health outcomes.

Metabolic syndrome

Associations between breakfast consumption and metabolic syndrome are unclear. The body of evidence is very small, with just three studies.[50,58,61] All used a prospective cohort study design, with risks of bias noted in **Table 25**. The three studies presented inconsistent findings. One study reported a significant association between skipping breakfast in adolescence and higher odds of metabolic syndrome in adulthood,[58] while the other two studies reported no significant associations between breakfast frequency in childhood and metabolic syndrome later in childhood[61] and between breakfast skipping in childhood and adolescence and metabolic syndrome in adulthood.[50]

Blood lipids, glucose, and insulin

This section synthesizes evidence about longitudinal outcomes. See the section Evidence synthesis: Physiological effects of breakfast consumption for outcomes measured following a breakfast meal.

Evidence from four prospective cohort studies[31,49,50,58] suggests that breakfast consumption in childhood and early adolescence may have short-term associations with some blood lipid outcomes, but that associations do not persist into adulthood. The only study that reported significant associations[49] assessed breakfast frequency at baseline, when participants were six to 13 years old, and change in blood lipids from baseline to one year later. Participants who reported eating breakfast more frequently had the largest increases in HDL cholesterol and largest decreases in total:HDL cholesterol, but changes in total cholesterol, LDL cholesterol, and triglycerides were not statistically different across breakfast frequency groups. The three remaining studies[31,50,58] were consistent in not reporting significant associations between breakfast consumption in adolescence (assessed between the ages of 11 and 16 years) and total cholesterol, HDL cholesterol, LDL cholesterol, or triglycerides in adulthood (assessed between the ages of 22 and 43 years). This finding is rational, because it is not biologically plausible for the childhood and adolescent diet to effect blood lipid measures in adulthood. This evidence should be interpreted with caution because it consists of just four observational studies, with risks of bias noted in **Table 25**.

Associations between breakfast consumption and fasting glucose and insulin are unclear. Evidence from three prospective cohort studies[49,50,58] that examined glucose was inconsistent. One study reported a significant association between skipping breakfast in adolescence and higher odds of high fasting glucose in adulthood,[58] but the other two studies reported no significant associations between breakfast frequency or breakfast skipping in childhood and adolescence and fasting glucose one year later[49] or in adulthood.[50] Likewise, evidence from two prospective cohort studies[30,50] that examined insulin was inconsistent. One study reported a significant association between eating breakfast daily throughout childhood, compared with less frequently, and lower HOMA-IR in adolescent males (but not females) (Gingras et al. 2018),[30] but the other study found no significant association between skipping breakfast in childhood and adolescence and HOMA-IR in adulthood

(Smith et al. 2010).[50] All of the studies in this small body of evidence were observational, with risks of bias noted in **Table 25**.

Blood pressure

Associations between breakfast consumption and blood pressure are unclear. The body of evidence is very small; two studies assessed short-term outcomes,[49,60] and two assessed long-term outcomes.[31,58] The studies that examined short-term outcomes reported inconsistent findings; one found no significant associations between breakfast frequency and 1-year changes in blood pressure in children and young adolescents,[49] while the other found a significant association between an increase in breakfast skipping and an increase in systolic (but not diastolic) blood pressure across a one-year period in adolescents.[60] Both studies that assessed long-term outcomes reported no significant association between child and adolescent breakfast consumption (measured at ages 11 to 13[31] and 16[58] years) and adulthood blood pressure (measured at ages 22[31] and 43[58] years). The four studies used a prospective cohort design, with risks of bias noted in **Table 25**.

Fitness

The association between breakfast consumption and fitness is unclear due to insufficient evidence. A single prospective cohort study[62] reported that an increase in breakfast frequency from age six to eight years was not associated with improvements in cardiorespiratory fitness, muscular strength, flexibility, or balance, but was associated with worse speed. These findings should be interpreted with caution because they are from a single observational study with a few key risks of bias noted in **Table 25**.

Summary statement:

- Associations between breakfast consumption during childhood and adolescence and long-term cardiometabolic health outcomes are unclear. The evidence was inconclusive because it was from a small number of studies with inconsistent findings and limitations.

Evidence synthesis – Breakfast consumption and longitudinal mental health outcomes

The evidence synthesized here is presented in **Table 26** and described in the results section Description of the evidence: Breakfast consumption and longitudinal mental health outcomes.

This small body of evidence found inconsistent associations between breakfast consumption and longitudinal mental health outcomes. Summarizing the evidence is complicated by the use of heterogeneous comparisons, outcomes, and analytic methods, and risks of bias (which are presented by study design in **Table 27**, **Table 28**, and **Table 29**).

Evidence from the single randomized controlled trial[38] was inconsistent with evidence from the remaining studies.[16,63,64] It found that one of the two 12-week breakfast conditions had an effect of higher perceived stress, when compared with the control group who maintained their usual habit of eating breakfast fewer than 3 days per week. Participants were 12 to 18 years of age.

The remaining studies reported both significant and nonsignificant associations, but all the significant associations pointed to a beneficial association between breakfast consumption and mental health outcomes:

- In a very large population-based cohort in Hong Kong, skipping breakfast in grades P6, S2, and S4 was associated with prospective emotional and behavioral problems in grades S2, S4, and S6.[64] Participants who reported skipping breakfast had higher odds of total emotional/behavioral problems than participants who reported eating breakfast at home and away from home. When compared with eating breakfast at home, skipping breakfast was associated with significantly higher odds of all subscales (withdrawal, somatic complaints, anxiety/depression, social problems, thought problems, attention problems, delinquent behaviors, and aggressive behaviors). On the other hand, when compared with eating breakfast away from home (such as at a fast-food restaurant), skipping breakfast was associated with significantly higher odds of somatic complaints, thought problems, and aggressive behaviors, only.

- In a large Japanese birth cohort, Chen et al.[63] reported that skipping breakfast at age nine years was not associated with poor quality of life three years later in a Japanese birth cohort. However, an increase in breakfast frequency from nine to 12 years was associated with significantly lower odds of poor quality of life at age 12 years, and a decrease in breakfast frequency from nine to 12 years was associated with significantly higher odds of poor quality of life at 12 years. This finding should be interpreted with caution, because it is possible that the significant associations result from reverse causality; that is, changes in the children's quality of life over the three-year period may have affected their breakfast frequency.
- In a non-randomized controlled trial, Smith[16] found that parent-reported mental health outcomes (alertness, emotional distress, depression, fatigue, negative mood) were better on day seven and day 14 in the ready-to-eat breakfast cereal groups than in the breakfast skipping groups. However, the findings should be interpreted with caution. Participants allocated to the breakfast skipping condition differed from participants allocated to the ready-to-eat cereal conditions because they were habitual breakfast skippers as opposed to habitual breakfast consumers. In addition, the findings may have resulted from reverse causality; that is, participants' mental health may have impacted their breakfast habits (and, therefore, group allocation in this study).

Summary statement:

- Associations between breakfast consumption during childhood and adolescence and long-term mental health outcomes are unclear. The evidence was inconclusive because it was from a small number of studies with inconsistent findings and limitations.

Research recommendations

1. Conduct additional trials and well-controlled longitudinal studies to examine relationships between breakfast consumption and health outcomes.

   Rationale: A small number of studies examined each health outcome. The generalizability of the findings is, therefore, limited. Additional studies need to be conducted for the body of evidence to represent school-aged children and adolescents across the entire 5- to 18-year age range and with differences in key characteristics (e.g., breakfast habit, weight status).

   Future studies should endeavor to:

   - Use strong study designs.

     Randomized controlled trials may be useful for examining acute effects of breakfast but may not be ethical to assess longitudinal effects if they allocate children and adolescents breakfast-skipping conditions across long periods of time. Non-randomized controlled trials and prospective cohort studies can assess longitudinal outcomes but must be carefully designed and conducted to reduce risks of bias (see next bullet).

   - Reduce the risk of bias through sound study design and conduct.

     The studies in the body of evidence had some risks of bias that could not be avoided. For example, in the randomized controlled trials, participants could not be blinded to their condition (they knew whether or not they were eating breakfast), and a lack of participant blinding could have impacted participant-reported outcomes. However, other risks of bias can and should be minimized. For example, pre-registering study protocols helps make it clear that there is not selective reporting bias. Prospective cohort studies need to carefully assess and control for key confounders. Valid and reliable methods should be used to assess all variables of interest, including breakfast exposures, outcomes, and confounders. Studies of multi-component programs that intend to impact many health behaviors need to isolate the associations of breakfast habits on outcomes. Research teams should attempt to minimize and clearly report missing data.

2. One study included in the body of evidence reported a finding that the Special Nutrition Research and Analysis Division at the FNS Office of Policy Support may deem worthy of a targeted examination: breakfast with different macronutrient compositions may impact appetite differently. In the case of the included study, a high-protein breakfast condition had a significant effect on appetite across the morning, but a normal-protein breakfast condition did not. The protocol for this rapid review did not target macronutrient composition; therefore, additional studies may exist that were not identified by the literature search and screening process.

Rapid review conclusions in context of existing narrative review

Murphy[a] summarized evidence published through 2005 that addressed breakfast consumption and a variety of health outcomes. In this section, we present Murphy's conclusions and discuss the results of the rapid review on breakfast consumption and health within the context of Murphy's literature review.

Murphy (Murphy, 2007) concluded that research from 1999 to 2005 "demonstrated a significant association between usual breakfast skipping and poorer mental health and health in children" (p 31).

The majority of research that Murphy summarized about mental health outcomes (i.e., stress, depression, mood, and "negative feeling states") was conducted in samples that were not part of the target population for our rapid review, such as young adults, undergraduate students, and adults. Only two cited studies (Cartwright et al. 2003; Fulkerson, Sherwood, Perry, Neumark-Sztainer, & Story, 2004) examined mental health outcomes (i.e., stress and depressive symptoms) in a target population (i.e., adolescents); however, both would have been excluded from the current rapid review due to their use of a cross-sectional analysis to study outcomes that were not acute.

Similarly, the majority of research Murphy summarized about other health outcomes examined topics that were not selected for examination in this rapid review, such as anemia, dysmenorrhea, and dental caries. Only two cited studies (Ball et al. 2003; Warren, Henry, & Simonite, 2003) examined health outcomes addressed in this rapid review (i.e., perceived hunger and satiety in children and adolescents); however, both lacked a breakfast-skipping comparison group and would have, therefore, been excluded from the current rapid review.

Murphy went on to conclude that "the findings about the connection between breakfast skipping and poorer mental health… replicate several previous studies of children and adults" and that "[t]he findings about the connection between breakfast skipping and poorer health are new for children" (p 31). The mental health findings prior to 1999 to which Murphy refers are also from studies of non-target populations, such as university students and adults, and studies that do not include breakfast-skipping comparison groups.

Therefore, the evidence presented in our rapid review, which included studies published since 2005, is distinct from the evidence published prior to 2005 presented in Murphy's literature review. We identified a small body of experimental and strong observational studies that compared breakfast consumption with breakfast skipping in school aged children and adolescents and examined outcomes within three domains of health: physiological

[a] Murphy, JM. Breakfast and learning: an updated review. *Current Nutrition & Food Science.* 2007; 3(1):3-36. https://doi.org/10.2174/1573401310703010003.

effects of breakfast consumption, longitudinal cardiometabolic health outcomes, and longitudinal mental health outcomes.

Table 22. Physiological effects of breakfast consumption[a]

Study	Notable participant characteristics	Intervention and comparator	Outcomes	Results
Adolphus et al. 2021[14] RCT (parallel) UK	Analytic N: 234 Mean age 12y Majority low SES (68% eligible for free school meals) Mean BMI SDS 0.69	Experimental condition (breakfast, fasting) * time (-25, 0, +15, +70, +95, +215, +240 min) interaction	Hunger [mm; $F_{(5, 1130)}$]	**≥ 2.54, p<0.05[b]** (Smaller increase from -25 to +240min in the breakfast condition than in the fasting condition)
		Breakfast condition vs fasting condition	Hunger at +15min [mm (SE)]	**19.86 (2.33) vs 72.46 (2.84), p< 0.0001**
			Hunger at +70min [mm (SE)]	**40.96 (2.99) vs 72.81 (2.85), p< 0.0001**
			Hunger at +95min [mm (SE)]	**38.30 (3.06) vs 74.62 (2.80), p< 0.0001**
			Hunger at +215min [mm (SE)]	**75.91 (2.45) vs 82.53 (2.38), p=0.0042**
			Hunger at +240min [mm (SE)]	**77.53 (2.48) vs 85.49 (2.08), p=0.0016**
Defeyter & Russo, 2013[7] RCT (crossover) UK	Analytic N: 40 Mean age 14y Habitual breakfast skippers Low SES Normal BMI	Experimental condition (breakfast, fasting) * time (-30 min, +135 min) interaction	Hunger [mm; $F_{(1,39)}$]	**6.73, p<0.05** (Larger decrease from -30 to +135 min in the breakfast condition than the fasting condition)
			Satiety [mm; $F_{(1,39)}$]	**11.06, p<0.05** (Larger increase from -30 to +135 min in the breakfast condition than the fasting condition)
			Alertness [mm; $F(1,39)$]	**12.89, p<0.05**

				(Increase from -30 to +135 min in the breakfast condition and decrease in the fasting condition)
			Calmness [mm; *F*(1,39)]	**5.96, p<0.05** (Smaller decrease from -30 to +135 min in the breakfast condition than the fasting condition)
			Contentment [mm; *F*(1,39)]	**9.53, p<0.05** (Increase from -30 to +135 min in the breakfast condition and decrease in the fasting condition)
Kawabata et al. 2021[2] RCT (parallel) Singapore	Analytic N: 40 Mean age 16y Majority female (78%) Normal BMI	Breakfast condition vs fasting condition (both conditions include 30 min of exercise at -30min)	Hunger at -70min [mm (SD)]	**60.8 (25.5) vs 51.6 (27.3), p<0.05**
			Change in hunger from -70 to +15min [mm (SD)]	**60.8 (25.5) to 16.8 (17.2) vs 51.6 (27.3) to 62.6 (30.2), p<0.05**
			Change in hunger from -70 to +140min [mm (SD)]	**60.8 (25.5) to 54.6 (31.9) vs 51.6 (27.3) to 57.0 (25.7), p<0.05**
			Appetite at -70min [mm (SD)]	71.6 (24.5) vs 67.8 (26.7), NS
			Change in appetite from -70 to +15min [mm (SD)]	**71.6 (24.5) to 26.5 (18.7) vs 67.8 (26.7) to 66.6 (31.3), p<0.05**
			Change in appetite from -70 to +140min [mm (SD)]	**71.6 (24.5) to 39.1 (24.9) vs 67.8 (26.7) to 73.8 (25.2), p<0.05**
			Satiety at -70min [mm (SD)]	**16.9 (17.0) vs 28.6 (21.9), p<0.05**
			Change in satiety from -70 to +15min [mm (SD)]	**16.9 (17.0) to 73.2 (19.6) vs 28.6 (21.9) to 20.4 (20.6), p<0.05**
			Change in satiety from -70 to +140min [mm (SD)]	**16.9 (17.0) to 53.4 (24.8) vs 28.6 (21.9) to 13.3 (15.0), p<0.05**

	Fullness at -70min [mm (SD)]	**7.6 (11.1) vs 21.9 (24.2), p<0.05**
	Change in fullness from -70 to +15min [mm (SD)]	**7.6 (11.1) to 69.3 (25.5) vs 21.9 (24.2) to 25.1 (27.8), P<0.05**
	Change in fullness from -70 to +140min [mm (SD)]	**7.6 (11.1) to 55.5 (28.7) vs 21.9 (24.2) to 23.1 (30.7), P<0.05**
	Arousal at -70min [mm (SD)]	2.80 (1.11) vs 2.86 (0.88), NS
	Change in arousal from -70 to +15min [mm (SD)]	2.80 (1.11) to 4.25 (1.12) vs 2.86 (0.88) to 3.75 (1.16), NS
	Change in arousal from -70 to +140min [mm (SD)]	2.80 (1.11) to 3.60 (1.27) vs 2.86 (0.88) to 3.20 (1.44), NS
	Feeling at -70min [mm (SD)]	1.25 (1.89) vs 1.35 (1.69), NS
	Change in feeling from -70 to +15min [mm (SD)]	**1.25 (1.89) to 2.90 (1.29) vs 1.35 (1.69) vs (1.80 (1.80), p<0.05**
	Change in feeling from -70 to +140min [mm (SD)]	1.25 (1.89) to 2.00 (1.78) vs 1.35 (1.69) to 1.30 (1.98), NS
	Motivation at -70min [mm (SD)]	6.90 (1.41) vs 6.80 (1.70), NS
	Change in motivation from -70 to +15min [mm (SD)]	6.90 (1.41) to 7.25 (1.77) vs 6.80 (1.70) to 6.25 (2.38), NS
	Change in motivation from -70 to +110min [mm (SD)]	6.90 (1.41) to 7.05 (1.79) vs 6.80 (1.70) to 5.45 (2.31), NS
	Mental effort at -40min [mm (SD)]	70.1 (24.9) vs 61.4 (23.1), NS
	Change in mental effort from -40 to +45min [mm (SD)]	**70.1 (24.9) to 59.3 (31.6) vs 61.4 (23.1) to 62.4 (26.5), p<0.05**
	Change in mental effort from -40 to +140min [mm (SD)]	70.1 (24.9) to 54.6 (31.9) vs 61.4 (23.1) to 57.0 (25.7), NS
Fasting condition vs breakfast condition (ref)	Change in glucose from -80 to +150min (mmol/L)	**-1.28, p<0.001**

Kral et al. 2005[10] RCT (crossover) US	Analytic N: 21 Mean age 9y Majority female (71%) Majority African-American (76%) Majority habitual breakfast consumers (~90%) Normal/overweight BMI	Experimental condition (breakfast, fasting) * time (+30, +45, +90, +135, +175 min) interaction	Energy (mm)	Data NR, NS
			Tiredness (mm)	Data NR, NS
			Well-being (mm)	Data NR, NS
			Cheerfulness (mm)	Data NR, NS
Leidy & Racki, 2010[59] RCT (crossover) US	Analytic N: 13 Mean age 14y Habitual breakfast skippers Normal/overweight BMI	Breakfast conditions (normal-protein and protein rich combined) vs fasting condition	Appetite, 240-min AUC (mm*240 min)	**Lower in breakfast condition (data NR), p<0.005**
			Satiety, 240-min AUC (mm*240 min)	**Higher in breakfast condition (data NR), p<0.01**
			Active ghrelin, 240-min AUC (pg/mL*240 min)	Lower in breakfast condition (data NR), NS
			Total PYY, 240-min AUC (pg/mL*240 min)	**Higher in breakfast condition (data NR), p<0.001**
		Normal-protein breakfast condition vs fasting condition	Appetite, 240-min AUC [mm*240 min (SEM)]	-8473 (2995) vs 4564 (3044), NS
			Appetite at +20min (mm)	**Lower in breakfast condition (data NR), p<0.05**
			Appetite at +240min [mm (SEM)]	**60.2 (4.4) vs 75.1 (4.4), p<0.05**

			Satiety, 240-min AUC [mm*240 min (SEM)]	**2996 (1223) vs -876 (572), p<0.01**
			Satiety at +20min (mm)	**Higher in breakfast condition (data NR), p<0.05**
			Satiety at +240min [mm (SEM)]	**18.5 (4.0) vs 7.3 (2.2), p<0.005**
			Active ghrelin at +20min (pg/mL)	NS (data NR)
			Active ghrelin at +240min (pg/mL)	NS (data NR)
			Total PYY, 240-min AUC [pg/mL*240 min (SEM)]	**1202 (769) vs -1587 (547), p<0.01**
		Protein-rich breakfast condition vs fasting condition	Appetite, 240-min AUC [mm*240 min (SEM)]	**-13542 (3667) vs 4564 (3044), p<0.01**
			Appetite at +20min (mm)	**Lower in breakfast condition (data NR), p<0.05**
			Appetite at +240min [mm (SEM)]	**48.9 (5.9) vs 75.1 (4.4), p<0.05**
			Satiety, 240-min AUC [mm*240 min (SEM)]	**4597 (1783) vs -876 (572), p<0.01**
			Satiety at +20min (mm)	**Higher in breakfast condition (data NR), p<0.05**
			Satiety at +240min [mm (SEM)]	**32.1 (5.8) vs 7.3 (2.2), p<0.005**
			Active ghrelin at +20min (pg/mL)	NS (data NR)
			Active ghrelin at +240min (pg/mL)	NS (data NR)
			Total PYY, 240-min AUC [pg/mL*240 min (SEM)]	**1830 (718) vs -1587 (547), p<0.001**
			Total PYY at +20min [pg/mL (SEM)]	**64.0 (3.6) vs 57.5 (4.1), p<0.01**
			Total PYY at +240min [pg/mL (SEM)]	**69.5 (5.2) vs 47.9 (4.6), p<0.0001**
Maffeis et al. 2012[11]	Analytic N: 10 Median age 9y; prepubertal	Breakfast condition vs fasting condition	Glucose, 180-min AUC [mmol/L*180min (SEM)]	**116.4 (19.7) vs 6.1 (11.4), p=0.001**

RCT (crossover) Italy	Obese BMI		
		Glucose at 0, +30, +60, +120, and +180min (mg/dL)	~79, **105,** 89, **90, 89 vs** ~79, **80,** 80, **79, 81;** **p<0.05 at +30, +120, +180 min**; NS at 0, +60 min
		Triglycerides, 180-min AUC [mmol/L*180min (SEM)]	**36.7 (11.5) vs -8.2 (5.5), p=0.003**
		Triglycerides at 0, +30, +60, +120, and +180min (mg/dL)	~95, 100, **105, 125, 130 vs** ~85, 80, **80, 80, 80;** **p<0.05 at +60, +120, +180 min;** NS at 0, +30 min
		Insulin, 180-min AUC [pmol/L*180min (SEM)]	**4856.2 (453.9) vs -927.0 (336.6), p<0.001**
		Glucagon, 180-min AUC [pmol/L*180min (SEM)]	**-115.4 (25.9) vs 83.0 (21.3), p=0.001**
		PYY, 180-min AUC [pmol/L*180min (SEM)]	-1.6 (5.2) vs -5.5 (7.5), NS
		Total GLP-1, 180-min AUC [pmol/L*180min (SEM)]	16.3 (13.6) vs 4.9 (9.9), NS
		Total ghrelin, 180-min AUC [pmol/L*180min (SEM)]	**-363 (103) vs -151 (81), p<0.02**
		Preprandial REE [kcal/min (SEM)]	1.04 (0.04) vs 1.04 (0.02), NS
		Postprandial REE [kcal/min (SEM)]	**1.16 (0.02) vs 1.07 (0.03), p<0.05**
		Preprandial protein oxidation [mg/min (SEM)]	32.7 (1.2) vs 32.7 (0.9), NS
		Postprandial protein oxidation [mg/min (SEM)]	34.8 (1.4) vs 32.1 (1.1), NS
		Preprandial carbohydrate oxidation [mg/min (SEM)]	80.0 (9.7) vs 64.8 (9.8), NS
		Postprandial carbohydrate oxidation [mg/min (SEM)]	**122.3 (9.0) vs 64.6 (8.6), p<0.05**
		Preprandial lipid oxidation [mg/min (SEM)]	68.4 (5.3) vs 72.2 (5.4), NS
		Postprandial lipid oxidation [mg/min (SEM)]	**58.0 (4.8) vs 73.8 (5.2), p<0.05**

Widenhorn-Müller et al. 2008[13] RCT (crossover) Germany	Analytic N: 104 Mean age 17y Majority habitual breakfast consumers (88%)	Fasting condition vs breakfast condition	Negative affect at +15min [points (SD)] • In males • In females	**Higher vs lower (data NR), p=0.037** • 3.96 (SD 3.25) vs 3.08 (SD 2.55), NS • 3.32 (SD 2.59) vs 2.82 (SD 2.63), NS
			Negative affect at +120min [points (SD)] • In males • In females	Higher vs lower (data NR), NS • 4.14 (SD 3.00) vs 3.92 (SD 3.25), NS • 4.12 (SD 2.95) vs 3.50 (SD 2.62), NS
			Positive affect at +15min [points (SD)] • In males • In females	**Lower vs higher (data NR), p=0.016** • **5.00 (SD 2.96) vs 6.38 (SD 2.69), p=0.002** • 6.04 (SD 2.25) vs 6.04 (SD 3.00), NS
			Positive affect at +120min [points (SD)] • In males • In females	Lower vs higher (data NR), NS • **4.29 (SD 2.97) vs 5.23 (SD 3.10), p=0.006** • 5.28 (SD 2.56) vs 5.18 (SD 3.04), NS
			Information uptake at +15min [points (SD)] • In males • In females	Lower vs higher (data NR), NS • **4.00 (SD 3.02) vs 5.33 (SD 2.64), p=0.012** • 5.54 (SD 2.54) vs 5.26 (SD 3.11), NS
			Information uptake at +120min [points (SD)] • In males • In females	Lower vs higher (data NR), NS • 3.38 (SD 2.71) vs 3.79 (SD 3.12), NS • 4.50 (SD 2.89) vs 4.62 (SD 3.22), NS
			Arousal at +15min [points (SD)] • In males • In females	Higher vs lower (data NR), NS • 2.79 (SD 2.64) vs 2.44 (SD 2.11), NS • 2.64 (SD 2.28) vs 2.22 (SD 1.85), NS
			Arousal at +120min [points (SD)]	Higher vs lower (data NR), NS

	• In males	• 3.38 (SD 2.29) vs 2.87 (SD 2.19), NS
	• In females	• 3.10 (SD 2.48) vs 2.92 (SD 2.39), NS
	Alertness at +15min [points (SD)]	**Lower vs higher (data NR), p=0.004**
	• In males	• 3.75 (SD 3.68) vs 4.79 (SD 3.33), NS
	• In females	• **3.78 (SD 2.86) vs 4.94 (SD 3.33), p=0.015**
	Alertness at +120min [points (SD)]	**Lower vs higher (data NR), p<0.001**
	• In males	• 4.54 (SD 3.58) vs 5.52 (SD 3.35), NS
	• In females	• **3.59 (SD 3.01) vs 5.04 (SD 3.28), p=0.001**

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[a] Abbreviations: AUC: area under the curve; BMI: body mass index; dL: deciliters; GLP-1: glucagon-like peptide-1; kcal: kilocalories; L: liters; mg: milligrams; min: minutes; mL: milliliters; mm: millimeters; mmol: millimoles; NR: not reported; NS: nonsignificant; pg: pictograms; pmol: picomoles; PYY: peptide YY; RCT: randomized controlled trial; REE: resting energy expenditure; ref: reference group; SD: standard deviation; SDS: standard deviation score; SE: standard error; SEM: standard error of the mean; SES: socioeconomic status; UK: United Kingdom; US: United States; y: years

[b] The study authors reported results of hunger and energy together, because they were similar, stating that the smallest intervention*time effect was $F_{(5,1130)}$=2.54, p<0.05

Table 23. Risk of bias for studies that examined the physiological effects of breakfast consumption[a]

Article	Randomization	Period and carryover effects	Deviations from intended interventions	Missing outcome data	Outcome measurement	Selection of the reported result
Adolphus et al. 2021[14] Parallel RCT	**SOME CONCERNS** Unclear concealment of allocation and baseline imbalances	**N/A**	**LOW**	**LOW**	**SOME CONCERNS** Lack of participant blinding may have affected participant-reported outcomes	**SOME CONCERNS** Retrospective protocol
Defeyter & Russo, 2013[7] Crossover RCT	**LOW**	**LOW**	**LOW**	**LOW**	**HIGH** Lack of participant blinding likely affected participant-reported mood outcomes **SOME CONCERNS** Lack of participant blinding may have affected participant-reported hunger and satiety outcomes	**SOME CONCERNS** No registered protocol reported
Kawabata et al. 2021[2] Parallel RCT	**SOME CONCERNS** Baseline differences between groups may relate to randomization or outcome measurement	**N/A**	**LOW**	**LOW**	**HIGH** Lack of participant blinding likely affected participant-reported outcomes at baseline **LOW** for objective outcomes	**SOME CONCERNS** No registered protocol reported
Kral et al. 2012[10] Crossover RCT	**SOME CONCERNS** Unclear concealment of allocation	**LOW**	**LOW**	**LOW**	**HIGH** Lack of participant blinding likely affected participant-reported outcomes	**SOME CONCERNS** No registered protocol reported

Leidy & Racki, 2010[59] Crossover RCT	**LOW**	**LOW**	**LOW**	**LOW**	**SOME CONCERNS** Lack of participant blinding may have affected participant-reported outcomes **LOW** for objective outcomes	**SOME CONCERNS** No registered protocol reported
Maffeis et al. 2012[11] Crossover RCT	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**SOME CONCERNS** No registered protocol reported
Widenhorn-Müller et al. 2008[13] Crossover RCT	**LOW**	**LOW**	**LOW**	**LOW**	**SOME CONCERNS** Lack of participant blinding may have affected participant-reported outcomes	**LOW**

[a] Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, Cates CJ, Cheng H-Y, Corbett MS, Eldridge SM, Hernán MA, Hopewell S, Hróbjartsson A, Junqueira DR, Jüni P, Kirkham JJ, Lasserson T, Li T, McAleenan A, Reeves BC, Shepperd S, Shrier I, Stewart LA, Tilling K, White IR, Whiting PF, Higgins JPT. RoB 2: a revised tool for assessing risk of bias in randomised trials. BMJ 2019; 366: l4898. https://doi.org/10.1136/bmj.l4898.

Table 24. Associations between breakfast and longitudinal cardiometabolic health outcomes[a]

Study	Notable participant characteristics	Exposure and comparator	Outcomes	Results
Gingras et al. 2018[30] PCS (Project Viva) US	Analytic N: 995 Daily breakfast intake stable from age 4y (86%) to 10y (84%) BMI: mean z-score 0.37 at age 4y SES: Majority had mothers who were married/cohabitating (92%) and college educated (71%), household income >$70k/y (64%) Race/ethnicity: 65% White, 3% Black, 16% Asian, 5% Hispanic, 12% Other	Eating breakfast daily vs ≤ 6 d/wk (ref.) from 4y to 10y	HOMA-IR at mean age 13y [% difference; β (95% CI)] • In males • In females	 • **-15.6 (-22.7, -7.9)** • -7.8 (-15.1, 0.1)
Goff et al. 2019[31] PCS (DASH) UK	Analytic N: 665 Breakfast skipping: 37% at 11-13y, 56% at 21-23y BMI: 24.7 kg/m^2 (39% >25 kg/m^2) at 21-23 y SES: representative of London Race/ethnicity: 16% White British, 15% Black Caribbean, 20% Black African, 15% Indian, 17% Bangladeshi or Pakistani, 17% other/mixed	Eating breakfast < 5 d/wk vs daily (ref.) at 11-13y	Total cholesterol at mean age 22y [mmol/L; β (95% CI)]	0.15 (-0.01, 0.31)
			HDL cholesterol at mean age 22y [mmol/L; β (95% CI)]	0.01 (-0.06, 0.08)
			Systolic blood pressure at mean age 22y [mmHg; β (95% CI)]	0.74 (-0.89, 2.38)
Kim et al. 2014[60]	Analytic N: 582 BMI: 23.5 kg/m^2 at 14.9y; 24.5 kg/m^2 at 16.2y	Increase in "usually skipping breakfast" from mean age 14.9y to 16.2y	Increase in systolic blood pressure from mean age 14.9y to 16.2y [mmHg; β (95% CI)]	**1.27 (0.13, 2.41), p=0.0295**

PCS (HEROES) US	Race: 18% Nonwhite, 82% White			
			Increase in diastolic blood pressure from mean age 14.9y to 16.2y [mmHg; β (95% CI)]	0.31 (-0.52, 1.14)
Meyer et al. 2014[61] PCS (Kinder-Sportstudie) Switzerland	Analytic N: 223 Breakfast skipping: 7% at 8y BMI: z-score 0.17, 20% overweight at 8y	Skipping breakfast ≥2 d/wk vs not skipping breakfast ≥2 d/wk at mean age 8y	High cardiovascular risk at mean 12y [probability (95% CI)]	0.64 (0.37, 0.84)
Shang et al. 2020[49] PCS China	Analytic N: 6964 Breakfast frequency at 6-13y: 2.2% 0 d/wk, 14.0% 1-6 d/wk, 83.8% 7 d/wk BMI: boys ~17, girls ~16 kg/m^2 SES: Mother's education: 9.2% <7y, 65.5% 7-12y, 23.2% ≥13y; Father's education: 13.1% <7y, 66.7% 7-12y, 17.82% ≥13 y	Breakfast frequency of 0 vs 1-6 vs 7 d/wk at 6-13y	Change in systolic blood pressure from baseline to 1y follow-up at 6-13y [mmHg (SE)]	4.06 (0.90) vs 2.14 (0.43) vs 2.41 (0.31), NS
			Change in diastolic blood pressure from baseline to 1y follow-up at 6-13y [mmHg (SE)]	2.55 (0.77) vs 0.68 (0.38) vs 1.08 (0.27), NS
			Change in total cholesterol from baseline to 1y follow-up at 6-13y [mmol/L (SE)]	−0.10 (0.05) vs −0.06 (0.02) vs −0.06 (0.02), NS
			Change in HDL cholesterol from baseline to 1y follow-up at 6-13y [mmol/L (SE)]	**0.09 (0.03) vs 0.11 (0.02) vs 0.14 (0.01), p(trend)=0.0044**
			Change in LDL cholesterol from baseline to 1y follow-up at 6-13y [mmol/L (SE)]	0.02 (0.05) vs 0.07 (0.03) vs 0.06 (0.02), NS

			Change in total:HDL cholesterol from baseline to 1y follow-up at 6-13y [ratio (SE)]	**−0.20 (0.05) vs −0.20 (0.03) vs −0.26 (0.02), p(trend)=0.0023**
			Change in triglycerides from baseline to 1y follow-up at 6-13y [mmol/L (SE)]	0.01 (0.04) vs 0.06 (0.02) vs 0.04 (0.01), NS
			Change in fasting glucose from baseline to 1y follow-up at 6-13y [mmol/L (SE)]	0.17 (0.05) vs 0.20 (0.03) vs 0.20 (0.03), NS
Smith et al. 2010[50] PCS (CDAH) Australia	Analytic N: 1583 Breakfast skipping: 0% at 28-36y Nationally representative	Not usually eating something before school at 9-15y vs Usually eating something before school at 9-15y (ref)	Metabolic syndrome at 28-36y [β (95% CI)]	0.02 (-0.07, 0.10)
			Fasting glucose at 28-36y [mmol/L; β (95% CI)]	-0.01 (-0.09, 0.06)
			Fasting insulin at 28-36y [mU/L; β (95% CI)]	-0.06 (-0.71, 0.59)
			HOMA-IR at 28-36y [β (95% CI)]	-0.02 (-0.19, 0.14)
			Triglycerides at 28-36y [mmol/L; β (95% CI)]	-0.02 (-0.15, 0.12)
			Total cholesterol at 28-36y [mmol/L; β (95% CI)]	-0.12 (-0.29, 0.05)
			LDL cholesterol at 28-36y [mmol/L; β (95% CI)]	-0.09 (-0.24, 0.06)
			HDL cholesterol at 28-36y [mmol/L; β (95% CI)]	-0.01 (-0.06, 0.04)
Wennberg et al. 2015[58] PCS (Northern Swedish Cohort) Sweden	Analytic N: 889 Breakfast skipping: 10% “poor breakfast habits” (no breakfast or just a caloric drink or sweet food) at 16y Nationally representative	Poor breakfast habits at 16y vs Eating breakfast at 16y (ref)	Metabolic syndrome at 43y [OR (95% CI)]	**1.68 (1.01, 2.78)**

			High triglycerides at 43y [OR (95% CI)]	1.48 (0.86, 2.53)
			Low HDL cholesterol at 43y [OR (95% CI)]	1.25 (0.76, 2.07)
			High fasting glucose at 43y [OR (95% CI)]	**1.75 (1.01, 3.02)**
			High blood pressure at 43y [OR (95% CI)]	1.17 (0.71, 1.91)
Zaquot et al. 2016[62] PCS (IDEFICS) Belgium, Cyprus, Estonia, Germany, Hungary, Italy, Spain, Sweden	Analytic N: 948-2263, depending on the outcome Breakfast frequency: mean 6 d/wk BMI: mean z-score 0.4	Increase in breakfast frequency (times/wk) from 6y to 8y	Change in 20m shuttle run from 6y to 8y (number of shuttles; β)	-0.047, NS
			Change in VO_{2max} from 6y to 8y (ml/kg/min; β)	0.063, NS
			Change in handgrip strength from 6y to 8y [kg; β (95% CI)]	-0.002, NS
			Change in standing long jump from 6y to 8y [cm; β (95% CI)]	-0.019, NS
			Change in 40m sprint from 6y to 8y [s; β (95% CI)]	**0.076, p=0.008**
			Change in sit-and-reach flexibility test from 6y to 8y [cm; β (95% CI)]	-0.021, NS
			Change in flamingo balance test from 6y to 8y [number of attempts; β (95% CI)]	-0.001, NS

[a] Abbreviations: BMI: body mass index; CDAH: Childhood Determinants of Adult Health study; CI: confidence interval; cm: centimeters; d: days; DASH: Determinants of Adolescent, now young Adults, Social well-being and Health study; HDL: high-density lipoprotein; HEROES: Healthy, Energetic, Ready, Outstanding, Enthusiastic Schools initiative; HOMA-IR:

homeostatic model assessment for insulin resistance; IDEFICS: IDentification and prevention of dietary and lifestyle induced health EFfects In Children and infantS study; kg: kilograms; L: liters; LDL: low-density lipoprotein; m: meters; mmHg: milimeters of mercury; min: minutes; ml: mililiters; mmol: milimoles; mU: miliunits; NS: nonsignificant; OR: odds ratio; PCS: prospective cohort study; ref: reference group; s: seconds; SE: standard error; SES: socioeconomic status; UK: United Kingdom; US: United States; VO_{2max}: maximal oxygen consumption; wk: week; y: years

Table 25. Risk of bias for studies that examined associations between breakfast consumption and longitudinal cardiometabolic health outcomes[a]

Article	Confounding (Key confounders: age, sex, race/ethnicity, physical activity, body weight)	Selection of participants	Classification of exposures	Deviations from intended exposures	Missing data	Outcome measurement	Selection of the reported result
Gingras et al. 2018[30]	**SERIOUS** Key confounders not accounted for: physical activity, body weight	**LOW**	**LOW**	**LOW**	**SERIOUS** ~50%	**LOW**	**LOW**
Goff et al. 2019[31]	**SERIOUS** Key confounders not accounted for: age, body weight	**LOW**	**LOW**	**LOW**	**MODERATE** ~25% for blood lipid data **LOW** for blood pressure data	**LOW**	**MODERATE** No registered protocol reported
Kim et al. 2014[60]	**SERIOUS** Key confounders not accounted for: race/ethnicity	**LOW**	**LOW**	**SERIOUS** Multicomponent program intended to impact many behaviors (co-exposures); it's unclear if co-exposures occurred and were balanced across exposure groups or adjusted for appropriately	**MODERATE** ~26%	**LOW**	**MODERATE** No registered protocol reported
Meyer et al. 2014[61]	**SERIOUS** Key confounders not accounted for: race/ethnicity, physical activity, body weight	**LOW**	**LOW**	**SERIOUS** Original trial intended to impact many behaviors (co-exposures); it's unclear if co-exposures occurred and were balanced across exposure groups	**CRITICAL** ~56% and those with missing data were more likely to skip breakfast	**LOW**	**MODERATE** No registered protocol reported
Shang et al. 2020[49]	**SERIOUS** Key confounders not accounted for: race/ethnicity	**LOW**	**LOW**	**LOW**	**MODERATE** ~19%	**LOW**	**MODERATE** No registered protocol reported

Smith et al. 2010[50]	**SERIOUS** Key confounders not accounted for: race/ethnicity, body weight	**LOW**	**LOW**	**LOW**	**CRITICAL** ~80% and those with missing data had higher BMI (and breakfast skipping had p=0.07)	**LOW**	**MODERATE** No registered protocol reported
Wennberg et al. 2015[58]	**SERIOUS** Key confounders not accounted for: age, race/ethnicity	**LOW**	**MODERATE** Unclear exposure assessment validity	**MODERATE** Exposure status may not have been stable during the follow-up period	**LOW**	**LOW**	**MODERATE** No registered protocol reported
Zaquot et al. 2016[62]	**SERIOUS** Key confounders not accounted for: age, sex, SES, race/ethnicity	**LOW**	**LOW**	**SERIOUS** Primary prevention program intended to impact many behaviors (co-exposures) associated with overweight/ obesity/related disorders; it's unclear if co-exposures occurred and were balanced across exposure groups	**CRITICAL** ~88% and the proportion of and reasons for missing data across exposure groups were not reported	**LOW**	**LOW**

[a] Risk of Bias for Nutrition Observational Studies" tool (RoBNObs) (Dietary Guidelines Advisory Committee. 2020. Scientific Report of the 2020 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Agriculture and the Secretary of Health and Human Services. U.S. Department of Agriculture, Agricultural Research Service, Washington, DC.

Table 26. Associations between breakfast and longitudinal mental health outcomes[a]

Study	Notable participant characteristics	Intervention or exposure and comparator	Outcomes	Results
Chen et al. 2005[63] PCS (Toyama Birth Cohort Study) Japan	Analytic N: 7794 Age: Mean 9.7y at baseline, 12.8y at follow-up	Breakfast often vs every day (ref) at 9y	Poor quality of life at 12y [OR (95% CI)]	1.09 (0.86, 1.38)
		Breakfast sometimes vs every day (ref) at 9y	Poor quality of life at 12y [OR (95% CI)]	1.17 (0.71, 1.95)
		Breakfast almost never vs every day (ref) at 9y	Poor quality of life at 12y [OR (95% CI)]	0.83 (0.39, 1.75)
		Breakfast often or every day at 9y and sometimes or almost never at 12y vs often or every day at 9y and at 12y (ref)	Poor quality of life at 12y [OR (95% CI)]	**1.44 (1.07, 1.93)**
		Breakfast sometimes or almost never at 9y and often or every day at 12y vs often or every day at 9y and at 12 y (ref)	Poor quality of life at 12y [OR (95% CI)]	**0.57 (0.33, 0.93)**
		Breakfast sometimes or almost never at 9y and at 12 y vs often or every day at 9y and at 12y (ref)	Poor quality of life at 12y [OR (95% CI)]	1.52 (0.68, 3.40)
Gong et al. 2021[64] PCS China	Analytic N: 115,217 Age: Mean 11.9y at baseline (grade P6) 84.5% breakfast at home, 8.7% breakfast away from	No breakfast vs Breakfast at home (ref) in grades P6, S2, and S4	Total emotional/behavioral problems in grades S2, S4, S6 [OR (95% CI)]	**1.87 (1.66, 2.10)**

home, 6.8% no breakfast in grade P6			
		Withdrawal in grades S2, S4, S6 [OR (95% CI)]	**1.52 (1.27, 1.82)**
		Somatic complaints in grades S2, S4, S6 [OR (95% CI)]	**2.12 (1.81, 2.48)**
		Anxiety/depression in grades S2, S4, S6 [OR (95% CI)]	**1.70 (1.40, 2.06)**
		Social problems in grades S2, S4, S6 [OR (95% CI)]	**1.34 (1.08, 1.66)**
		Thought problems in grades S2, S4, S6 [OR (95% CI)]	**1.67 (1.37, 2.04)**
		Attention problems in grades S2, S4, S6 [OR (95% CI)]	**1.82 (1.51, 2.19)**
		Delinquent behaviors in grades S2, S4, S6 [OR (95% CI)]	**2.29 (1.89, 2.79)**
		Aggressive behaviors in grades S2, S4, S6 [OR (95% CI)]	**2.08 (1.73, 2.49)**
	No breakfast vs Breakfast away from home (ref) in grades P6, S2, and S4	Total emotional/behavioral problems in grades S2, S4, S6 [OR (95% CI)]	**1.28 (1.11, 1.48)**
		Withdrawal in grades S2, S4, S6 [OR (95% CI)]	1.24 (1.00, 1.55)
		Somatic complaints in grades S2, S4, S6 [OR (95% CI)]	**1.51 (1.23, 1.85)**
		Anxiety/depression in grades S2, S4, S6 [OR (95% CI)]	1.19 (0.94, 1.53)
		Social problems in grades S2, S4, S6 [OR (95% CI)]	1.18 (0.89, 1.54)
		Thought problems in grades S2, S4, S6 [OR (95% CI)]	**1.31 (1.02, 1.70)**

			Attention problems in grades S2, S4, S6 [OR (95% CI)]	1.19 (0.95, 1.50)
			Delinquent behaviors in grades S2, S4, S6 [OR (95% CI)]	1.12 (0.89, 1.42)
			Aggressive behaviors in grades S2, S4, S6 [OR (95% CI)]	**1.34 (1.06, 1.70)**
Kim et al. 2021[38] RCT (parallel) Korea	Analytic N: 105 (ITT), 87 (PP), 81 (good compliance) Age 12-18y (mean 15y) Habitual breakfast consumption <3 d/wk	Rice-based breakfast vs usual intake	Change in perceived stress from baseline to 12-wk follow up [points (SD)]	19.71 (3.61) to 19.37 (3.14) vs 19.31 (4.79) to 19.17 (3.90); NS
		Wheat-based breakfast vs usual intake	Change in perceived stress from baseline to 12-wk follow up [points (SD)]	**21.00 (3.69) to 21.02 (4.09) vs 19.31 (4.79) to 19.17 (3.90), p=0.016**
Smith, 2010[16] NRCT UK	Analytic N: 213 Age: 8y	No breakfast vs Cornflakes	Alertness before breakfast [units NR, mean (SE)] • On day 7 • On day 14	 • **377 (24) vs 430 (18), p<0.05** • **414 (25) vs 434 (18), p<0.05**
			Alertness after breakfast [units NR, mean (SE)] • On day 7 • On day 14	 • **583 (17) vs 611 (13), p<0.05** • **623 (18) vs 635 (13), p<0.05**
			Emotional distress [units NR, mean (SE)] • On day 7 • On day 14	 • **28.8 (1.4) vs 26.3 (1.0), p<0.05** • **27.8 (1.3) vs 22.5 (1.0), p<0.05**
			Depression [units NR, mean (SE)] • On day 7 • On day 14	 • **1.5 (0.2) vs 0.7 (0.2), p<0.05** • **1.3 (0.2) vs 0.3 (0.2), p<0.05**
			Fatigue [units NR, mean (SE)] • On day 7	 • **18.2 (0.7) vs 14.8 (0.5), p<0.05**

	• On day 14	• **16.4 (0.7) vs 13.7 (0.5), p<0.05**
	Negative mood [units NR, mean (SE)]	
	• On day 7	• **12.7 (0.09) vs 8.4 (0.7), p<0.05**
	• On day 14	• **10.7 (0.09) vs 6.3 (0.7), p<0.05**
No breakfast vs Rice Krispies	Alertness before breakfast [units NR, mean (SE)]	
	• On day 7	• **377 (24) vs 459 (17), p<0.05**
	• On day 14	• **414 (25) vs 474 (18), p<0.05**
	Alertness after breakfast [units NR, mean (SE)]	
	• On day 7	• **583 (17) vs 617 (12), p<0.05**
	• On day 14	• **623 (18) vs 640 (12), p<0.05**
	Emotional distress [units NR, mean (SE)]	
	• On day 7	• **28.8 (1.4) vs 23.6 (0.9), p<0.05**
	• On day 14	• **27.8 (1.3) vs 21.9 (1.0), p<0.05**
	Depression [units NR, mean (SE)]	
	• On day 7	• **1.5 (0.2) vs 0.7 (0.2), p<0.05**
	• On day 14	• **1.3 (0.2) vs 0.6 (0.2), p<0.05**
	Fatigue [units NR, mean (SE)]	
	• On day 7	• **18.2 (0.7) vs 14.8 (0.5), p<0.05**
	• On day 14	• **16.4 (0.7) vs 14.3 (0.5), p<0.05**
	Negative mood [units NR, mean (SE)]	
	• On day 7	• **12.7 (0.09) vs 7.9 (0.7), p<0.05**
	• On day 14	• **10.7 (0.09) vs 7.0 (0.7), p<0.05**
No breakfast vs Rice Krispies Multigrain	Alertness before breakfast [units NR, mean (SE)]	
	• On day 7	• **377 (24) vs 498 (19), p<0.05**
	• On day 14	• **414 (25) vs 501 (20), p<0.05**

Alertness after breakfast [units NR, mean (SE)]	
• On day 7	• **583 (17) vs 653 (14), p<0.05**
• On day 14	• **623 (18) vs 674 (13), p<0.05**
Emotional distress [units NR, mean (SE)]	
• On day 7	• **28.8 (1.4) vs 22.2 (1.0), p<0.05**
• On day 14	• **27.8 (1.3) vs 21.4 (1.0), p<0.05**
Depression [units NR, mean (SE)]	
• On day 7	• **1.5 (0.2) vs 0.8 (0.2), p<0.05**
• On day 14	• **1.3 (0.2) vs 0.6 (0.2), p<0.05**
Fatigue [units NR, mean (SE)]	
• On day 7	• **18.2 (0.7) vs 14.4 (0.5), p<0.05**
• On day 14	• **16.4 (0.7) vs 13.1 (0.6), p<0.05**
Negative mood [units NR, mean (SE)]	
• On day 7	• **12.7 (0.09) vs 7.9 (0.7), p<0.05**
• On day 14	• **10.7 (0.09) vs 6.8 (0.7), p<0.05**

[a] Abbreviations: CI: confidence interval; d: days; ITT: intention-to-treat analysis; NR: not reported; NRCT: non-randomized controlled trial; NS: nonsignificant; OR: odds ratio; P6: primary grade 6; PCS: prospective cohort study; PP: per-protocol analysis; RCT: randomized controlled trial; ref: reference group; S2, S4, S6: secondary grades 2, 4, and 6; SD: standard deviation; SE: standard error; wk: week; y: years

Table 27. Risk of bias for the randomized controlled trial that examined associations between breakfast consumption and longitudinal mental health outcomes[a]

Article	Randomization	Deviations from intended interventions	Missing outcome data	Outcome measurement	Selection of the reported result
Kim et al. 2021[38] Parallel RCT	LOW	LOW	LOW	SOME CONCERNS Lack of participant blinding may have affected participant-reported outcomes	LOW

[a] Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, Cates CJ, Cheng H-Y, Corbett MS, Eldridge SM, Hernán MA, Hopewell S, Hróbjartsson A, Junqueira DR, Jüni P, Kirkham JJ, Lasserson T, Li T, McAleenan A, Reeves BC, Shepperd S, Shrier I, Stewart LA, Tilling K, White IR, Whiting PF, Higgins JPT. RoB 2: a revised tool for assessing risk of bias in randomised trials. BMJ 2019; 366: l4898. https://doi.org/10.1136/bmj.l4898.

Table 28. Risk of bias for the non-randomized controlled trial that examined associations between breakfast consumption and longitudinal mental health outcomes [a]

Article	Confounding (Key confounders: age, sex, race/ethnicity, physical activity, body weight)	Selection of participants	Classification of interventions	Deviations from intended interventions	Missing data	Outcome measurement	Selection of the reported result
Smith, 2010[16]	CRITICAL Key confounders not accounted for: age, sex, race/ethnicity, physical activity, body weight	LOW	LOW	LOW	LOW	SERIOUS Assessment may not have been valid/reliable for the age group, and lack of parent blinding may have affected the parent-reported outcomes	LOW

[a] Sterne JAC, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, Henry D, Altman DG, Ansari MT, Boutron I, Carpenter JR, Chan AW, Churchill R, Deeks JJ, Hróbjartsson A, Kirkham J, Jüni P, Loke YK, Pigott TD, Ramsay CR, Regidor D, Rothstein HR, Sandhu L, Santaguida PL, Schünemann HJ, Shea B, Shrier I, Tugwell P, Turner L, Valentine JC, Waddington H, Waters E, Wells GA, Whiting PF, Higgins JPT. ROBINS-I: a tool for assessing risk of bias in non-randomized studies of interventions. BMJ 2016; 355; i4919; https://doi.org/10.1136/bmj.i4919.

Table 29. Risk of bias for the prospective cohort studies that examined associations between breakfast consumption and longitudinal mental health outcomes [a]

Article	**Confounding** (Key confounders: age, sex, race/ethnicity, physical activity, body weight)	Selection of participants	Classification of exposures	Deviations from intended exposures	Missing data	Outcome measurement	Selection of the reported result
Chen et al. 2005[63]	**SERIOUS** Key confounders not accounted for: race/ethnicity	**LOW**	**LOW**	**LOW**	**MODERATE** ~25%	**LOW**	**MODERATE** No registered protocol reported
Gong et al. 2021[64]	**SERIOUS** Key confounders not accounted for: race/ethnicity	**LOW**	**LOW**	**LOW**	**MODERATE** ~34%	**LOW**	**MODERATE** No registered protocol reported

[a] Risk of Bias for Nutrition Observational Studies" tool (RoBNObs) (Dietary Guidelines Advisory Committee. 2020. Scientific Report of the 2020 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Agriculture and the Secretary of Health and Human Services. U.S. Department of Agriculture, Agricultural Research Service, Washington, DC.

Key Question 2: What best practices exist in the U.S. School Breakfast Program, including models of student costs and breakfast delivery?

This section briefly discusses findings from observational studies, and synthesis of evidence for student cost and breakfast delivery models and evidence across non-traditional SBP models. Rapid review summary statements are based on an evaluation of trial data; however, research recommendations took evidence from CS and UPP studies into consideration. Observational studies provide a link between findings reported by Murphy[a] and trial evidence. Risk of bias assessment for RCTs are summarized in **Table 33**, risk of bias assessments for NRCTs are summarized in **Table 34** and risk of bias assessment for observational studies are found in **Table 35**. The first column of each table indicates the article and the model/s tested.

Evidence synthesis - Student cost models

One cluster-RCT[69] and four NRCTs[71,74,75,77] examined the effect of UFB compared to eligibility pricing on SBP participation, diet quality, breakfast skipping, school performance (attendance and low attendance) and learning achievement. Results were consistent across studies for SBP participation and learning achievement, only one study evaluated diet quality and breakfast skipping, and results on student attendance were inconsistent.

All studies were designed to answer the research question. The cluster-RCT used a strong study design with sufficient power, had a low attrition rate, and enrolled a geographically and economically diverse sample of elementary schools from around the country.[69] A 24-hour recall from student and parent interviews was used to assess breakfast skipping and diet quality. NRCTs were large and one moderate sized, well-controlled and used strong analytic methods (e.g., difference-in-difference analysis). Studies included elementary schools, middle schools, and high schools from both urban and rural areas. Participants were from a range of SES and racial/ethnic backgrounds, with a high proportion of students eligible for FRP meals. Three NRCTs accounted for all key confounders;[71,74,75] and one study did not.[77] Authors reported no conflict of interest.

Evidence synthesis - Breakfast delivery models

Breakfast in the classroom model

One RCT[65,68] and four NRCTs[70-73] examined the effect of BIC on SBP participation,[68,70,72] breakfast skipping and diet quality, [65] attendance,[70-73] academic achievement,[70-73] and weight related outcomes.[68,72] Results were consistent for SBP participation and learning achievement, results were inconsistent for attendance, and weight-related outcomes and only one study evaluated breakfast skipping and diet quality outcomes.

Included studies were designed to answer the research question. Polonsky et al.[68] used a rigorous RCT design to evaluate a BIC intervention with a strong nutrition education and marketing component in fourth to sixth graders from high-poverty, urban schools over a 2.5-year period. The RCT had a high attrition rate (42 percent) due to student transfer between schools; however, a weighted generalized estimate equation was used to address missing data and analysis focused on adherence to the protocol versus intention-to-treat. High attrition left the study underpowered. Outcome assessors were not blinded to the intervention but followed a standard protocol to measure student height and weight and determine weight status. Polonsky[68] reported outcomes in an *a priori* analysis plan, however, outcomes from this trial reported by Bauer et al.[65] (breakfast skipping and diet quality) were not describe in the plan.

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[a] Murphy, JM. Breakfast and learning: an updated review. *Current Nutrition & Food Science*. 2007; 3(1):3-36. https://doi.org/10.2174/1573401310703010003.

Corcoran et al.[72] used a difference-in-difference design and intent-to-treat analysis to evaluate staggered intervention of BIC in New York City schools over a five-year period; however, analysis was not controlled for multiple comparisons. Height and weight were measured by school staff annually as part of the school physical education program. BMI results exclude students in school years where the fitness participation was lower than 50 percent and results were stratified by degree of BIC implementation.

The NRCTs[70-73] were natural experiments, which used objective, reliable administrative sources for school delivery model data and outcomes on SBP participation, attendance, and academic achievement. Most studies controlled for all key confounders; however, one study did not control for: age/grade, race/ethnicity, and SES and another did not control for school or cluster. No NRCT had an *a priori* analysis plan, increasing risk for selective reporting. Most studies were conducted in racially diverse, low-income urban elementary and middle schools; and, one study included primarily white, higher-income elementary school students from Wisconsin (excluding schools from Milwaukee). BIC was not evaluated in high schools. Authors reported no conflict of interest.

Other breakfast after the bell delivery models

One RCT (2 articles) and 1 NRCT examined BAB delivery models.

- Nanney et al.[67] in a well-controlled and adequately powered RCT demonstrated a BAB intervention using eligibility pricing increased SBP participation in high schools with low SBP participation, and Hearst et al.[66] found implementation of this BAB intervention for one year had no significant effect on weighted GPA among students who reported frequent breakfast skipping.
- Kirksey and Gottfied [76] found schools with BAB compared to those without BAB significantly reduced chronic absenteeism at all school levels, but the magnitude of effect was particularly strong in high schools. Results from Kirksey and Gottfried, 2021 must be interpreted with caution, since analysis was based on school assignment to BAB, not student participation in BAB and analysis only included schools with close to 70 percent of students eligible for FRP meals.

Evidence synthesis - Across non-traditional student cost and breakfast delivery models

- Thirteen articles from three cluster-RCT and eight NRCT, published between January 2006 and August 2021 examined the effect of SBP student cost and breakfast delivery models on SBP participation, breakfast skipping, diet quality, school performance, learning achievement, and weight-related outcomes.
- Results were consistent across non-traditional student cost and breakfast delivery models
  - Most studies examined the effect of SBP student cost or breakfast delivery models on SBP participation. Three RCTs[67-69] and five NRCTs[70,72,74,75,77] found UFB and/or BAB delivery models, particularly BIC, significantly increased SBP participation among elementary, middle and high school students and among students eligible and not eligible for free and reduced priced meals.
  - Two rigorous RCTs[65,69] found that UFB or BIC compared to traditional SBP delivery significantly increased rates of nutritionally substantive breakfast consumption.
  - Few studies evaluated weight-related outcomes and evidence was inconsistent. One RCT[68] and one NRCT[72] found universal free-BIC compared to UFB in the cafeteria had no significant effect on BMI z-score; however, the RCT reported an increase in the incidence and prevalence of obesity at 1.5 and 2.5 years among fourth through sixth graders, while the NRCT found little effect in second through sixth graders over a 5-year period.

- Predominately null effects were reported in NRCTs examining the effect of student cost[74,75] or breakfast delivery models[71-73,76] on student attendance; however, one study found significant findings when assessing the effect of BAB on chronic absenteeism.[76]
- Predominately null effects were reported from NRCTs examining UFB,[71,74,75] BIC or BAB[70-73] and learning achievement over periods ranging from 11-weeks to 5-years.

- Studies used objective, reliable administrative sources for school delivery model data and outcomes related to SBP participation, attendance, and academic achievement and
  - RCTs predominantly had low risk of bias, however, some outcomes were not included in a pre-registered analysis plan.
  - The majority of NRCTs were natural experiments which employed rigorous analytic methods (e.g., difference-in-difference analysis) and adjusted for age or grade, race/ethnicity, SES, and school or cluster characteristics. No NRCT had a registered protocol, and several studies failed to control for multiple comparisons, increasing the risk for spurious findings.
- Studies were conducted in racially diverse, low-income urban elementary and middle schools; however, a few studies included high schools, and schools from rural and higher income communities.

<u>Summary statements</u>

- U.S. School Breakfast Program universal-free breakfast and breakfast-after-the-bell delivery models, particularly breakfast in the classroom (or a combination of these models) compared to traditional School Breakfast Program delivery, significantly and substantially increases School Breakfast Program participation. Evidence is from large, well designed intervention studies conducted in diverse grades and socioeconomic student groups.
- U-free breakfast or breakfast in the classroom may increase rates of consuming a nutritionally substantive breakfast (e.g., consume food from at least two of five food groups and intake of greater than 10% of daily energy requirements). Evidence is from two large, rigorous intervention studies conducted in high-poverty, urban elementary and middle schools.
- The effect of universal-free breakfast in the classroom on weight-related outcomes is unclear due to insufficient evidence. However, one rigorous study conducted in high-poverty urban schools found breakfast in the classroom increased the incidence of obesity but found breakfast in the classroom had no significant effect on combined incidence of overweight and obesity at 2.5 years of intervention. Additional longitudinal research is needed on the impact of free breakfast in the classroom on weight-related outcomes and eating behaviors using research designs with sufficient power to explore the effect of baseline weight, socioeconomic status, and urbanicity.
- Breakfast in the classroom and universal-free School Breakfast Program have little effect on measures of attendance and academic achievement during the first year of implementation in elementary and middle school children. Additional longitudinal research is needed on universal-free breakfast and breakfast-after-the-bell models and measures of attendance, and chronic absenteeism, particularly among high school students.
- The relationship between the School Breakfast Program student cost and delivery models and breakfast skipping, student/teacher satisfaction, and health is unclear due to lack of evidence.

Research recommendations

Additional research is needed to assess best practices in U.S. SBP pricing and breakfast delivery models that examine:

- the impact of BIC on weight-related outcomes using strong, longitudinal study designs that have sufficient power to explore the effect of breakfast pricing, baseline weight, school level, SES, and urbanicity.
- the effect of SBP delivery and student cost models over multiple years on different measures of attendance and absenteeism and across school levels, SES, and achievement subgroups. Research in high schools is particularly warranted.
- the effect of BAB delivery methods in middle and high schools from all regions of the country, especially rural school districts.
- diet quality, and a wider variety of school performance and learning achievement outcomes over multiple years.

Rapid review conclusions in context of an existing narrative review

Murphy[a] reviewed literature on UFB pricing models from the national, state, and local UFB demonstration projects but did not review literature on SBP models of breakfast delivery. The author in that review reported findings from The SBP Pilot Project (conducted in 2000-2003), specifically, that UFB leads to statistically and clinically significant increases in SBP participation, which in turn increases the number of students who have a nutritionally substantive breakfast in the morning. Murphy also found SBP delivery and student cost models were not associated with attendance or standardized test scores. Based on the first year SBP Project report (2000-2001)[b], Murphy reported no significant differences in terms of cognitive test results (visual discrimination, memory for digits, verbal fluency), parent- and teacher-rated psychosocial problems, and academic achievement (test scores for math and reading) between kids in schools that received UFB and kids in matched schools that received traditional SBP. Finally, Murphy reported that UFB is generally not associated with significant improvements in BMI, or health, although some early state and local demonstration projects found positive effects.

The recent literature goes beyond Murphy's analysis of UFB pricing by examining BIC, grab-and-go, and SCB delivery models. New evidence confirms and builds upon previous findings that UFB and BAB delivery models, particularly BIC (or a combination of these models), compared to the traditional SBP model, increases SBP participation and increases rates of nutritionally substantive breakfast consumption. Consistent with findings by Murphy, current evidence does not demonstrate that SBP student cost and delivery models effect student attendance or standardized test scores and evidence related to BMI and health is unclear.

The recent literature differs from the literature reviewed by Murphy in a couple ways. First, Murphy reviewed data that were from governmental or research institution reports, and an unpublished analysis of SBP data. The conclusions drawn in the present review are based on large randomized controlled and non-randomized controlled studies identified using a systematic search of peer reviewed literature. Additionally, the recent

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[a] Murphy, JM. Breakfast and learning: an updated review. *Current Nutrition & Food Science.* 2007; 3(1):3-36. https://doi.org/10.2174/157340131070301000З.

[b] McLaughlin J, Bernstein L, Crepinsek M, Daft L, Murphy JM.Evaluation of the School Breakfast Program Pilot Project: Findings from the First Year of Implementation. Alexandria VA: U.S.Department of Agriculture; 2002. http: //www.fns.usda.gov/oane/ MENU/Published/CNP/FILES/BreakfastPilotYr1.pdf.

literature includes data from elementary, middle, and high schools in both rural and urban settings, whereas the data available to Murphy included more information from middle school students in urban areas.

Table 30. Evidence from randomized controlled trials and non-randomized controlled trials on the effect of student cost

Study, Design, Grade(s), Setting	Notable participant characteristics	Intervention and comparator	Outcomes	Results
Crepinsek, 2006[69] **Cluster RCT (SBP Pilot Project)** **ES, grades 2-6** **Nationally representative**	Analytic N: 4,278 students (153 schools) Race/ethnicity: 38% non-white SES: 54% FRP	UFB (18/79 schools UFB-BIC) (N=2,212 students) vs Traditional SBP[a] (N=2,066 students) Duration: 1 y	Change in SBP participation during first year of implementation in grades 2-6 (%)	**16 to 40 vs 16 to 22, p<0.01**
			Any breakfast consumption in grades 2-6 (units NR)	NS (data NR)
			Nutritionally substantive breakfast consumption in grades 2-6 (%)	**80 vs 76, p<0.01**
Bartfeld, 2019[71] **NRCT** **ES, grades 1-5** **WI (excluding Milwaukee schools)**	Analytic N: 1,007 schools (attendance: 481,799 students, 325,815 likely SBP students, 736,807 higher-income students; test scores: 248,328 students, 105,341 likely-SBP students, 308,478 higher-income students) Race/ethnicity: ~80% White; ~5% Black; ~8% Hispanic; ~4% Asian SES: ~31% likely SBP students (<185% of the poverty line and received SNAP at some point in the past 3y)	UFB vs Traditional SBP (ref) Duration: 5 y	Attendance rate in grades 1-5 [% annual school days attended, β (SE)] All students Likely-SBP students Higher-income students	 **0.24 (0.11), p=0.023** 0.23 (0.16), NS **0.31 (0.09), p<0.01**
			Low attendance in grades 1-5 [probability of attending <95% of annual school days, β (SE)] All students Likely-SBP students	 **-0.035 (0.009), p<0.001** **-0.033 (0.011), p<0.01**

			Higher-income students	**-0.035 (0.011), p<0.01**
			Normalized math scores in grades 3-5 [β (SD)] All students Likely-SBP students Higher-income students	 0.03 (0.03), NS −0.01 (0.03), NS **0.07 (0.02), p<0.01**
			Normalized reading scores in grades 3-5 [β (SD)] All students Likely-SBP students Higher-income students	0.01 (0.03), NS −0.03 (0.03), NS **0.04 (0.02), p<0.05**
Leos-Urbel, 2013[74] **NRCT** **ES and MS, grades 3-8** **New York, NY**	Analytic N: 723,843 students (667 schools) Race/ethnicity: ~33.1% Black, ~38.6% Hispanic, ~13.2% Asian, ~15.1% White SES: ~84.1% FRP	Change in SBP price from eligibility pricing to UFB (schools offered eligibility pricing before and UFB after a policy change) vs No change in SBP price/always UFB (schools offered UFB before and after a policy change) (ref) Duration: 1 y	School-level SBP participation in grades 3-8 [log average number of meals served per year per student, β (SE)] In students eligible for free meals In students eligible for reduced-price meals In students eligible for full-price meals *Results reported among schools with <33% and <66% of students eligible for free lunch were also significant, see Leos-Urbel, 2013*	 **0.05 (0.02), p<0.05** **0.21 (0.08), p<0.01** **0.36 (0.12), p<0.01**
			Student-level attendance rate in grades 3-8 [% enrolled school days attended per year, β (SE)] In students eligible for free meals In students not eligible for free meals *Additional results reported by eligibility status for black, Hispanic, Asian, and white students. Significant results found among black students eligible for free meals, and Asian students not eligible for free meals. See Leos-Urbel, 2013.*	0.11 (0.09), NS 0.14 (0.10), NS
			Student-level reading achievement in grades	

			3-8 [z-score on statewide standardized test, β (SE)]	
			In students eligible for free meals	0.01 (0.01), NS
			In students not eligible for free meals	0.01 (0.01), NS
			All results reported by eligibility status for black, Hispanic, Asian, and white students not significant. See Leos-Urbel, 2013	
			Student-level math achievement in grades 3-8 [z-score on statewide standardized test, β (SE)] In students eligible for free meals In students not eligible for free meals *All results reported by eligibility status for black, Hispanic, Asian, and white students not significant. See Leos-Urbel, 2013*	0.02 (0.01), NS -0.01 (0.01), NS
Ribar, 2013[75] **NRCT** **ES, grades 1-5** **NC**	Analytic N: 8,078 students (10 schools); grade 1- 5; 4,797 students grade 3-5: 4,797 Race/ethnicity: 46.5-68.6% Black, 12.4-24.0% Hispanic SES: 70-95% FRP	UFB vs. Traditional SBP Duration: 1 y	SBP participation, difference-in-difference analyses All in grades 1-5 Eligible for free meals Eligible for RP meals Eligible for paid meals	**β=0.164 (SE=0.054), p<0.05** **β=0.133 (SE=0.046), p<0.05** **β=0.209 (SE=0.085), p<0.05** **β=0.275 (SE=0.101), p<0.05**
			Attendance rate, using student-level data Grades 1-5 Grades 3-5 Economically disadvantaged (n=3,773) Non-disadvantaged (n=1,024)	**β=--0.005 (SE=0.001), p=0 .01** **β=--0.005 (SE=0.001), p=0 .01** **β=--0.006 (SE=0.002), p=0.01** **β** =--0.003 (SE=0.002), NS
			Math proficiency test scores in grades 3-5	
			Economically disadvantaged	β=0.014 (SE=0.030), NS
			Non-disadvantaged	β=0.045 (SE=0.063), NS
			Reading proficiency test scores grades 3-5	

			Economically disadvantaged	β=0.006 (SE=0.011), NS
			Non-disadvantaged	β=0.029 (SE=0.039), NS
			Science proficiency test scores in 5th grade	
			Economically disadvantaged	**β=0.068 (SE=0.029), p<0.05**
			Non-disadvantaged	β=0.740 (SE=0.911), NS
Schneider, 2021[77] **NRCT** **ES, MS, HS, grades K-12** **TX, state-wide**	Analytic N: 2,797 schools Race/ethnicity: 15.1% White, 12.9% Black, 68.8% Hispanic, 1.5% Asian, 0.3% American Indian SES: 88.9% FRP	Opting into CEP (among schools that were ever eligible and ever opted in during a 6-y period) vs. Not opting into CEP (among schools that were ever eligible and ever opted in during a 6-y period)	Change in monthly SBP participation rate [average % (SE), difference-in-difference analysis]	
			Full calendar year	**3.44 (0.50), p<0.001**
			School year (excluding June-August)	**3.65 (0.52), p<0.001**

[a] Traditional SBP is breakfast served before school in the cafeteria with eligibility pricing.

Table 31. Evidence from randomized controlled trials and non-randomized controlled trials on the effect of breakfast delivery models of U.S. School Breakfast Program delivery on SBP participation, breakfast skipping, diet quality, school performance, learning achievement, and weight-related outcomes[a]

Study, Design, Grade(s), Setting	Notable participant characteristics	Intervention and comparator	Outcomes	Results
Bauer, 2019[65] Cluster RCT (One Healthy Breakfast initiative) ES, grades 4-6 Philadelphia, PA	Analytic N: 16 schools (1,362 students) Median schoolwide SBP participation rate: 18.2% Race/ethnicity: 66.6% Black, 17.1% Hispanic, 6.1% Asian, 7.3% White, 2.9% multiple or other SES: 78.9% FRP Weight status: 2.5% underweight, 58.4% healthy weight, 17.7% overweight, 21.4% obese	UFB-BIC + nutrition education + social marketing and marketing at nearby corner stores to promote healthy breakfast + parent outreach (N=639 students at 8 schools) for 2.5 y vs UFB in the cafeteria + existing nutrition education through SNAP-ED (ref) (N=723 students at 8 schools) Duration: 2.5 y	Breakfast skipping [OR (95% CI)] At 1.5y (grades 5-7) At 2.5y (grades 6-8)	 **0.56 (0.37, 0.86)** 0.99 (0.72, 1.36)
			Food Consumption pattern meeting USDA nutritional requirements [OR (95% CI)] At 1.5y (grades 5-7) At 2.5y (grades 6-8)	 **3.43 (2.03, 5.80)** **3.09 (1.82, 5.25)**
Polonsky, 2019[68] Cluster RCT (One Healthy Breakfast initiative) ES, grades 4-6 Philadelphia, PA	Analytic N: 16 schools (1362 students) Median schoolwide SBP participation rate: 18.2% Race/ethnicity: 66.6% Black, 17.1% Hispanic, 6.1% Asian, 7.3% White, 2.9% multiple or other SES: 78.9% FRP Weight status: 2.5% underweight, 58.4% healthy weight, 17.7% overweight, 21.4% obese	UFB-BIC + nutrition education + social marketing and marketing at nearby corner stores to promote healthy breakfast + parent outreach (N=639 students at 8 schools) vs UFB in the cafeteria + existing nutrition education through SNAP-ED (ref) (N=723 students at 8 schools) Duration: 2.5 y	SBP participation [β (95% CI)] At 1.5y (grades 5-7) At 2.5y (grades 6-8)	 **0.46 (0.38, 0.53)** **0.33 (0.24, 0.42)**

			BMI z-score [β (95% CI)]	
			At 1.5y (grades 5-7)	0.03 (−0.11, 0.17)
			At 2.5y (grades 6-8)	0.07 (−0.08, 0.22)
			Incidence of overweight and obesity [OR (95% CI)]	
			At 1.5y (grades 5-7)	1.63 (0.95, 2.80)
			At 2.5y (grades 6-8)	1.42 (0.82, 2.44)
			Prevalence of overweight and obesity [OR (95% CI)]	
			At 1.5y (grades 5-7)	1.16 (0.91, 1.48)
			At 2.5y (grades 6-8)	1.22 (0.96, 1.54)
			Incidence of obesity [OR (95% CI)]	
			At 1.5y (grades 5-7)	**1.72 (1.02, 2.90)**
			At 2.5y (grades 6-8)	**3.27 (1.87, 5.73)**
			Prevalence of obesity [OR (95% CI)]	
			At 1.5y (grades 5-7)	1.10 (0.89, 1.35)
			At 2.5y (grades 6-8)	**1.43 (1.08, 1.89)**
Hearst, 2019[66] Cluster RCT (Project breakFAST) HS, grades 9-10 MN (rural)	Analytic N: 636 students (from 13 schools) Habitual breakfast skippers (<3 d/wk) Race/ethnicity: 76% White SES: 34% FRP Unweighted cumulative GPA: mean 2.82 (SD 0.78)	Traditional SBP (N=336 students from 7 schools) vs Breakfast in the cafeteria before school + grab-n-go breakfast outside the cafeteria (before school and/or second-chance breakfast) + policy permitting eating in the hallway/some classrooms + SBP marketing campaign + implementation training (N=300 students from 6 schools) Duration: 1 y	Change in unweighted cumulative GPA from pre-intervention to end of 1 year of intervention in grades 10 and 11 [mean (SD)]	
			All students	2.92 (0.74) to 2.92 (0.71) vs 2.70 (0.82) to 2.68 (0.81), NS
			Low-resource students	2.53 (0.82) to 2.54 (0.74) vs 2.34 (0.82) to 2.28 (0.81), NS
			High-resource students	3.04 (0.67) to 3.04 (0.67) vs 2.80 (0.79) to 2.79 (0.77), NS
Nanney, 2019[67]	Analytic N: 16 schools Low SBP participation at baseline (all <20%; median 13.1%)	Traditional SBP (N=8 schools) vs	School-level change in SBP participation following 1y intervention in grades 10-11 [%, median (IQR)]	**0.5 (0.7) vs 3 (13.5), p=0.03**

Cluster RCT (Project breakFAST) HS, grades 9-10 MN (rural)	Race/ethnicity: median 87.8% non-Hispanic White SES: median 32.2% FRP	Breakfast in the cafeteria before school + grab-n-go breakfast outside the cafeteria (before school and/or second-chance breakfast) + policy permitting eating in the hallway/some classrooms + SBP marketing campaign + implementation training (N=8 schools) Duration: 1y		
Anzman-Frasca, 2015[70] NRCT ES, grades K-6 “Large urban school district”	Analytic N: 446 schools (423 schools for SBP participation analyses) Race/ethnicity: >70% Hispanic/Latino SES: >80% FRP	UFB-BIC (N=257 schools) vs Traditional SBP[a] (N=189 schools) Duration: 1 y of implementation	SBP participation in grades K-6 (mean monthly % students) *See Anzman-Frasca, 2015 for additional results reported by month*	**73.7 vs 42.9, p<0.001**
			Attendance rate in grades K-6 (%)	**95.48 vs 95.34 (mean difference of 76 student-days), p=0.004**
			High attendance in grades K-6 (% students who attend ≥96% of enrolled school days)	**Data NR, p=0.04**
			Math achievement in grades 2-6 (% students in each grade who achieved state benchmarks on yearly standardized tests)	57.9 vs 57.4, NS
			Reading achievement in grades 2-6 (% students in each grade who achieved state benchmarks on yearly standardized tests)	44.9 vs 44.7, NS
Bartfeld, 2019[71] NRCT ES, grades 1-5 WI (excluding Milwaukee schools)	Analytic N: 1,007 schools (attendance: 481,799 students, 325,815 likely SBP students, 736,807 higher-income students; test scores: 248,328 students, 105,341 likely-SBP students, 308,478 higher-income students) Race/ethnicity: ~80% White; ~5% Black; ~8% Hispanic; ~4% Asian SES: ~31% likely SBP students (<185% of the poverty line and	BIC (UFB and eligibility pricing) vs Traditional SBP Duration: 5 y	Attendance rate in grades 1-5 [% annual school days attended, β (SE)] All students Likely-SBP students Higher-income students	 0.07 (0.09), NS -0.03 (0.12), NS 0.13 (0.09), NS

	received SNAP at some point in the past 3y)			
			Low attendance in grades 1-5 [probability of attending <95% of annual school days, β (SE)] All students Likely-SBP students Higher-income students	-0.002 (0.007), NS 0.007 (0.010), NS -0.006 (0.007), NS
			Normalized math scores in grades 3-5 [β (SD)] All students Likely-SBP students Higher-income students	−0.01 (0.01), NS −0.03 (0.02), NS 0.00 (0.02), NS
			Normalized reading scores in grades 3-5 [β (SD)] All students Likely-SBP students Higher-income students	(0.01), NS −0.00 (0.02), NS 0.00 (0.01), NS
Corcoran, 2016[72] NRCT ES and MS, grades K-8 New York, NY	Analytic N: 1,088 schools Race/ethnicity: never BIC, <25%, 25-99%%, and 100% BIC adoption: 12%, 12%, 3%, 5% Asian; 34%, 35%, 43%, 35% Black; 15%, 14%, 3%, 56% Hispanic; 15%, 14%, 3%, 4% White SES: % eligible for free meal: 67% never BIC, 69% BIC <25%, 82% 25-99% BIC, 81% 100% BIC	UFB-BIC vs UFB in the cafeteria before school Duration: 5 y	Average daily SBP participation in grades K-8 [β (SE)] In all schools with <25% BIC In ES only In MS only In all schools with 25-99% BIC In ES only In MS only In all schools with 100% BIC In ES only In MS only BMIz [β (SE)]	 **0.044 (0.006), p<0.001** **0.045 (0.007), p<0.001** **0.042 (0.011), p<0.001** **0.195 (0.018), p<0.001** **0.197 (0.021), p<0.001** **0.226 (0.040), p<0.001** **0.302 (0.032), p<0.001** **0.333 (0.043), p<0.001** **0.336 (0.032), p<0.001**

School-level (pre-post indicator)	
In schools with <25% BIC	
In ES	-0.0008 (0.0143), NS
In MS	-0.0236 (0.0175), NS
In schools with 25-99% BIC	
In ES	-0.0045 (0.0159), NS
In MS	-0.0171 (0.0393), NS
In schools with 100% BIC	
In ES	-0.0164 (0.0304), NS
In MS	-0.0301 (0.0187), NS
Student-level (cumulative days of exposure)	
In schools with <25% BIC	
In ES	**0.0107 (0.0053), p<0.05**
In MS	0.0080 (0.0045), NS
In schools with 25-99% BIC	
In ES	-0.0017 (0.0067), NS
In MS	0.0109 (0.0082), NS
In schools with 100% BIC	
In ES	-0.0263 (0.0169), NS
In MS	0.0040 (0.0087), NS
Obesity prevalence [β (SE)]	
School-level (pre-post indicator)	
In schools with <25% BIC	
In ES	-0.0013 (0.0037), NS
In MS	-0.0085 (0.0062), NS
In schools with 25-99% BIC	
In ES	0.0011 (0.0047), NS

In MS	-0.0100 (0.0154), NS
In schools with 100% BIC	
In ES	-0.0023 (0.0086), NS
In MS	-0.0053 (0.0066), NS
Student-level (cumulative days of exposure)	
In schools with <25% BIC	
In ES	**0.0029 (0.0014), p<0.05**
In MS	0.0029 (0.0016), NS
In schools with 25-99% BIC	
In ES	0.0018 (0.0020), NS
In MS	0.0035 (0.0032), NS
In schools with 100% BIC	
In ES	-0.0032 (0.0059), NS
In MS	0.0015 (0.0033), NS
Attendance [β (SE)]	
School-level (pre-post indicator)	
In schools with <25% BIC	
In ES	<0.001 (0.001), NS
In MS	0.001 (0.001), NS
In schools with 25-99% BIC	
In ES	0.001 (0.001), NS
In MS	0.004 (0.002), NS
In schools with 100% BIC	
In ES	0.001 (0.001), NS
In MS	0.005 (0.003), NS
Student-level (cumulative days of exposure)	

In schools with <25% BIC	
In ES	<0.001 (0.001), NS
In MS	0.001 (0.001), NS
In schools with 25-99% BIC	
In ES	0.001 (0.001), NS
In MS	0.001 (0.001), NS
In schools with 100% BIC	
In ES	<0.001 (0.001), NS
In MS	<0.001 (0.001), NS
ELA achievement [β (SE)]	
School-level (pre-post indicator)	
In schools with <25% BIC	
In grades 4-5	-0.004 (0.009), NS
In MS	0.008 (0.010), NS
In schools with 25-99% BIC	
In grades 4-5	-0.012 (0.015), NS
In MS	-0.019 (0.010), NS
In schools with 100% BIC	
In grades 4-5	-0.043 (0.026), NS
In MS	-0.016 (0.019), NS
Student-level (cumulative days of exposure)	
In schools with <25% BIC	
In grades 4-5	-0.002 (0.003), NS
In MS	0.001 (0.003), NS
In schools with 25-99% BIC	
In grades 4-5	-0.005 (0.004), NS
In MS	-0.005 (0.003), NS

			In schools with 100% BIC	
			In grades 4-5	-0.008 (0.009), NS
			In MS	-0.006 (0.004), NS
			Math achievement [β (SE)]	
			School-level (pre-post indicator)	
			In schools with <25% BIC	
			In grades 4-5	-0.004 (0.011), NS
			In MS	0.009 (0.013), NS
			In schools with 25-99% BIC	
			In grades 4-5	-0.019 (0.019), NS
			In MS	0.010 (0.017), NS
			In schools with 100% BIC	
			In grades 4-5	0.023 (0.037), NS
			In MS	-0.005 (0.034), NS
			Student-level (cumulative days of exposure)	
			In schools with <25% BIC	
			In grades 4-5	-0.003 (0.004), NS
			In MS	0.002 (0.005), NS
			In schools with 25-99% BIC	
			In grades 4-5	-0.006 (0.005), NS
			In MS	**0.007 (0.004), p<0.05**
			In schools with 100% BIC	
			In grades 4-5	0.013 (0.010), NS
			In MS	0.013 (0.009), NS
Imberman, 2014[73] NRCT ES, grade 5	Analytic N: Math and reading achievement 6,353 students (84 schools), attendance 38,425	UFB-BIC vs UFB in the cafeteria		Math achievement in grade 5 [standardized test scores, β (SE)]	
			All students	β=0.086 (SE=0.046), NS

Urban district in southwest USA	students (87 schools), grades 37,309 students (87 schools)	Duration: 11 weeks	Students not eligible for free lunch	0.008 (0.056), NS
	Race/ethnicity: 23% Black, 1-2% White, 73-74% Hispanic		Students eligible for free lunch	**0.132 (0.050), p<0.01**
	SES: 94% FRP		*See Imberman, 2014 for results reported by sex, race, ethnicity prior-year achievement, English proficiency, and BMI category*	
			Reading achievement in grade 5 [standardized test scores, β (SE)]	
			All students	β=0.062 (SE=0.034), NS
			Students not eligible for free lunch	**0.083 (0.038), p<0.05**
			Students eligible for free lunch	0.046 (0.043), NS
			See Imberman, 2014 for results reported by prior-year achievement, sex, race, ethnicity, English proficiency, and BMI category	
			Attendance rate in grades 1-5 [β (SE)]	0.060 (0.075), NS
			No significant results when analyzed by grade and prior-year achievement, see Imberman, 2014	
			Grades in grades 1-5 [mean across all courses in 9-week period, β (SE)]	0.010 (0.035), NS
			No significant results when analyzed by grade and prior-year achievement, see Imberman, 2014	
Kirksey, 2021[76]	Analytic N: 1,883 schools	Breakfast after the bell (including BIC, breakfast in the cafeteria after the bell, grab-n-go)	Change in school-level rate of chronic absenteeism [% students missing >15d of the school year (SE)]	
NRCT	Schools had close to 70% students eligible for FRP lunch (state policy required breakfast after the bell in schools with ≥70% FRP lunch eligibility).	vs	All schools close to 70% FRP	**-0.04 (0.01), p<0.01**
ES, MS, HS, grades K-12		Traditional SBP or UFB in the cafeteria	ES (1,111 schools)	**-0.03 (0.01), p<0.01**
CO and NV (state data)	Race/ethnicity: 35% Latinx, 5% Black, 3% Asian	Duration: 1 y	MS (301 schools)	**-0.03 (0.01), p<0.05**
	SES: 48% FRP		HS (339 schools)	**-0.07 (0.02), p<0.001**
			Change in school-level reading achievement [% (SE)]	

		In CO (1,381 schools)	-0.02 (0.02), NS
		In NV (502 schools)	0.04 (0.07), NS
		Change in school-level math achievement [% (SE)]	
		In CO (1,381 schools)	0.01 (0.02), NS
		In NV (502 schools)	0.03 (0.04), NS

[a] Abbreviations: BIC: breakfast in the classroom; BMI: body mass index; CI: confidence interval; CO: Colorado; ES: elementary school; FRP: eligible for free and reduced-price school meals; GPA: grade point average; HS: high school; K: kindergarten; MN: Minnesota; MS: middle school, NR: not reported; NRCT: Non-randomized controlled trial; NS: non-significant; NV: Nevada; NY: New York; OR: odds ratio; PA: Pennsylvania; Project breakFAST: Fueling Academics and Strengthening Teens; RCT: randomized controlled trial; SBP: U.S. School Breakfast Program; SD: standard deviation; SE: standard error; SES: socioeconomic status; SNAP-ED: Supplemental Nutrition Assistance Program Education; UFB: universal free breakfast; USA: United States of America; USDA: U.S. Department of Agriculture; vs: versus; WI: Wisconsin; y: year

Table 32: Evidence from cross-sectional and uncontrolled pre/post studies on the relationship between U.S. SBP models of student cost and breakfast delivery and SBP participation, breakfast skipping, diet quality, satisfaction, school performance, and weight[a]

Study, Design, Grade(s), Setting	Notable participant characteristics	Exposure and comparator	Outcomes	
Bartfeld, 2010[78 b] CS ECLS-K (2002 data) ES, grade 3 National sample	Analytic N: 6,680 students (1,125 schools) Race/ethnicity: NR SES: ~9% food insecure; Highest parental education 11.5% less than HS, 25.7% HS, 36.4% some college,15.6% college degree, 10.8% graduate degree	BIC vs Tradition SBP[c] (ref)	SBP participation in grade 3 [β (SE); OR (95% CI)]	**0.857 (0.219), p<0.01;** 2.357 (NR)
		Breakfast in common areas vs Traditional SBP (ref)	SBP participation in grade 3 [β (SE); OR (95% CI)]	0.136 (0.240), NS; 1.146 (NR)
		Breakfast in other locations vs Traditional SBP (ref)	SBP participation in grade 3 [β (SE); OR (95% CI)]	-0.573 (0.473), NS; 0.563 (NR)
		Duration of the breakfast period[a]	SBP participation in grade 3 [β (SE); OR (95% CI)]	**0.006 (0.003), p<0.05**; 1.006 (NR)

[a]Abbreviations: BIC: breakfast in the classroom; BMI: body mass index; CA: California; CI: confidence interval; CO: Colorado; d: days; ES: elementary school; FRP: eligible for free and reduced-price school meals; GPA: grade point average; HS: high school; IQR: inter-quartile range; K: kindergarten; MN: Minnesota; MS: middle school, NR: not reported; NRCT: Non-randomized controlled trial; NS: non-significant; NV: Nevada; NY: New York; OR: odds ratio; PA: Pennsylvania; Project breakFAST: Fueling Academics and Strengthening Teens; RCT: randomized controlled trial; SBP: U.S. School Breakfast Program; SC: South Carolina; SD: standard deviation; SE: standard error; SES: socioeconomic status; SNAP-ED: Supplemental Nutrition Assistance Program Education; UFB: universal free breakfast; USA: United States of America; USDA: U.S. Department of Agriculture; vs: versus; WI: Wisconsin; y: year

[b] Bartfeld, 2010 does not describe this exposure variable well; it may be a continuous variable, but the units used for the analysis (e.g., per minute) are not reported

[c] Traditional SBP is breakfast served before school in the cafeteria with eligibility pricing.

		10-20 min between school bus riders' arrival at school and start of class vs <10 min (ref)	SBP participation in grade 3 [β (SE); OR (95% CI)]	**0.538 (0.115), p<0.001**; 1.713 (NR)
		>20 min between school bus riders' arrival at school and start of class vs <10 min (ref)	SBP participation in grade 3 [β (SE); OR (95% CI)]	**1.582 (0.154), p<0.01**; 4.864
Baxter, 2010[79] CS (same study as Guinn, 2013) ES, grade 4 SC	Analytic N: 1,571 students (17 schools [year 1 and 2] or 8 schools [year 3]) Race/ethnicity: 90% Black SES: high percentage FRP (data NR)	BIC (6, 6, and 7 schools across 3 y) vs Traditional SBP (ref) (11, 11, and 1 school/s across 3 y)	BMI in grade 4 [mean kg/m^2, β (SE)] *See Baxter, 2010 for additional results reported for students observed eating SBP and NSLP on the same day*	**0.88 (NR), p=0.012**
			BMI category in grade 4 [OR (95% CI)] *See Baxter, 2010 for additional results reported for students observed eating SBP and NSLP on the same day*	1.31 (NR), p=0.054
Grannon, 2020[85] UPP (Project breakFAST) HS, grades 9-10 MN (rural)	<u>School-level data:</u> Analytic N: 12 schools Low SBP participation at baseline (mean 16.3%) Race/ethnicity: 2-32% non-white SES: 23-57% FRP	Traditional SBP (year 1, grades 9-10) vs Traditional SBP + grab-n-go breakfast outside the cafeteria (before school and/or second-chance breakfast) + policy permitting eating in the hallway/some classrooms + SBP marketing campaign (year 2, grades 10-11)	School-level school year SBP participation rate [%, mean (range)] Total Before-school Second-chance	 **16.3 (7.9, 38.1) vs 25.7 (13.3, 48.4), p=0.004** 16.3 (7.9, 38.1) vs 13.3 (3.8, 38.8), NS NA (not offered) vs 12.4 (0.7, 31.8)
	<u>Student-level data:</u> Analytic N: 578 students Habitual breakfast skippers (<3 d/wk)	Traditional SBP (year 1, grades 9-10) vs Traditional SBP + grab-n-go breakfast outside the cafeteria (before school and/or second-chance breakfast) + policy permitting eating in the hallway/some	Student-level school year SBP participation rate [%, mean (range)] Total	 **13.5 (3.0, 33.2) vs 28.6 (9.2, 56.6) p=0.006**

	Race/ethnicity: 37% non-white SES: 40% FRP; 16% food insecure	classrooms + SBP marketing campaign (year 2, grades 10-11)	Before-school Second-chance	13.5 (3.0, 33.2) vs 13.4 (1.8, 40.4), NS NA (not offered) vs 15.2 (2.5, 31.5)
Guinn, 2013[80] CS (same study as Baxter, 2010) ES, grade 4 SC	Analytic N: 1,060 students (17 schools [year 1] or 8 schools [year 2]) Race/ethnicity: 91% Black SES: 85% FRP	BIC vs Traditional SBP (ref)	SBP participation in grade 4 [d (% of 180 school d)]	**127.4 (71) vs 68.5 (38), p<0.0001**
Larson, 2018[86] UPP (Project breakFAST) HS, grades 9-10 MN (rural)	Analytic N: 8 schools (3,200 students) N:364 at-risk students (eat breakfast <3d/wk) N: 126 at-risk and eligible for FRP meals Race/ethnicity: 83% non-Hispanic white SES: ~34% eligible for FRP meals	Pre-implementation: Traditional SBP, students are not permitted to eat in the hallway vs. Post-intervention: Grab-and-Go or SCB in a high traffic area, students permitted to eat in the hallways and classrooms, and pre-recorded implementation training. Note: Implemented in 2 waves over consecutive years, baseline 1 and 2.	SBP participation (school-level), Mean (SD) Baseline 1 (grades 9-10 to 11-12) Base line 2 grades (grades 10-11 to 11-12) See Larson, 2018 for results reported by race, ethnicity, and eligibility category.	 **13.0 vs 22.6, p=0.03** **13.9 vs 22.6, p=0.02**
			SBP participation (at-risk students), Mean (SD) Baseline 1 (grades 9-10 to 11-12) Base line 2 grades (grades 10-11 to 11-12)	 **7.6 vs 21.9, p<0.001** **10.0 vs 21.9, p<0.001**
			Eligible for FRP meals: Baseline 1 (grades 9-10 to 11-12) Base line 2 grades (grades 10-11 to 11-12) A significant increase in SBP participation was also found among at-risk students not eligible for FRP meals, Hispanic students, and white	 **13.9 vs 30.7, p<0.001** **19.5 vs 30.7, p<0.001**

			students. See Larson, 2018 for more details.	
Leider, 2020[81] CS (School Nutrition and Meal Cost Study) ES, MS, HS, grades 1-12 Nationally representative	Full sample: Analytic N: 1,575 students Race/ethnicity: 49.5% non-Hispanic white, 14.5% non-Hispanic black, 27.7% Hispanic, 8.3% other SES: Household income as % poverty level: 38.8% <130%, 10.5% >130-185%, 50.6% >185%	UFB vs Traditional SBP (ref)	SBP participation in grades 1-12 [OR (95% CI)]	**3.52 (2.18, 5.69), p<0.001**
	Subsample (students who sometimes eat school breakfast): Analytic N: 726 students Race/ethnicity: 38.1% non-Hispanic white, 20.8% non-Hispanic black, 33.5% Hispanic, 7.5% other SES: Household income as % poverty level: 56.6% <130%, 13.3% >130-185%, 30.2% >185%	UFB vs Traditional SBP (ref)	Liking SBP in grades 1-12 [OR (95% CI)]	**0.57 (0.34, 0.94), p=0.028**
Nanney, 2011[88] UPP MS, grade 6 Minneapolis, MN	Analytic N: 239 students (1 school) Race/ethnicity: 68.1% White, 8.3% African American, 4.2% Hispanic, 5.6% Asian, 13.4% other SES: 36.4% FRP	Traditional SBP vs Traditional SBP + grab-n-go	SBP participation (average d/wk) in grade 6	
			All students	**0.74 vs 1.21, p<0.0001**
			Students eligible for FRP meals (~88 students)	**1.16 vs 1.79, p<0.0001**
			Students eligible for full price meals (~159 students)	**0.33 vs 0.62, p=0.0002**
			See Nanney, 2011 for additional results reported by sex	
Moeltner, 2019[87] UPP	Analytic N: 161 students (3 schools)	Traditional SBP (baseline, grades 3-4) vs	SBP participation (mean %)	**37.10 vs 55.08, p=0.01**

ES, grades 3-5 NV (Reno/Sparks metropolitan area)	Race/ethnicity: 3% Black, 63% Hispanic, 1% Asian, 18% White, <1% native SES: ~84% FRP	Traditional SBP + 10 more minutes (all students go to the cafeteria for 10 min after the bell and breakfast service remains open) (time point 1, grades 3-4)		
			Skipping breakfast (mean %)	**12.79 vs 10.34, p=0.05**
		Traditional SBP (baseline, grades 3-4) vs UFB-BIC (time point 2, grades 3-5)	SBP participation (mean %)	**37.10 vs 98.6, p=0.01**
			Skipping breakfast (mean %)	**12.79 vs 0.52, p=0.01**
Ritchie, 2015[82] CS ES, grades 4-5 CA	Analytic N: 3,944 students from 43 schools (subsamples: 429 breakfast skippers, 3,515 breakfast eaters) Race/ethnicity: 49.2% Hispanic, 12.5% non-Hispanic white, 9.1% non-Hispanic black, 8.5% Asian, 1.4% American Indian/ Alaskan native, 1.7% Native Hawaiian/Pacific Islander, 16.7% other SES: 72.1% FRP	BIC (1,530 students from 17 schools) vs SBP in the cafeteria (1,825 students from 20 schools)	Breakfast skipping in grades 4-5 (% students)	**8.4 vs 13.1, p<0.05**
			Diet quality in grades 4-5 [HEI 2010 score (SD)] • In the subsample of breakfast skippers (429 students) • In the subsample of breakfast eaters (3525 students)	**50.3 (11.3) vs 47.0 (11.8), p<0.05** • **48.9 (13.1) vs 44.7 (11.2), p<0.05** • **50.4 (11.1) vs 47.4 (11.8), p<0.05**
		BIC (1,530 students from 17 schools) vs	Breakfast skipping in grades 4-5 (% students)	8.4% vs 10.4%, NS

		SBP in the cafeteria + SCB at first recess (589 students from 6 schools)		
			Diet quality in grades 4-5 [HEI 2010 score (SD)]	**50.3 (11.3) vs 46.0 (11.0), p<0.05**
			• In the subsample of breakfast skippers (429 students)	• **48.9 (13.1) vs 42.9 (11.0), p<0.05**
			• In the subsample of breakfast eaters (3525 students)	• **50.4 (11.1) vs 46.3 (11.0), p<0.05**
Soldavini, 2019[83] CS ES, MS, HS, grades K-12 NC	Analytic N: 2,285 schools (1,445,287 students) Race/ethnicity: NR SES: 61% FRP UFB: 53% schools	UFB (including CEP), all delivery models (N=1213 schools) vs Traditional SBP (ref) (N=830 schools)	SBP participation [OR (95% CI)]	
			All ES students	**1.54 (1.33, 1.78)**
			Paid students	**3.55 (2.88, 4.39)**
			FRP students	**1.23 (1.07, 1.40)**
			All MS students	**1.33 (1.12, 1.57)**
			Paid students	**3.41 (2.78, 4.18)**
			FRP students	**1.17 (1.03, 1.33)**
			All HS students	**1.32 (1.04, 1.68)**
			Paid students	**4.46 (3.32, 5.99)**
			FRP students	1.04 (0.86, 1.27)
		BIC (N=338) vs Traditional SBP (ref) (N=830 schools)	SBP participation [OR (95% CI)]	
			All ES students	**1.49 (1.14, 1.93)**
			Paid students	**1.81 (1.23, 2.67)**
			FRP students	**1.35 (1.05, 1.75)**
			All MS students	1.21 (0.80, 1.85)
			Paid students	1.07 (0.35, 2.27)
			FRP students	1.17 (0.83, 1.66)
			All HS students	**2.12 (1.20, 3.75)**
			Paid students	**3.79 (1.58, 9.09)**
			FRP students	**1.79 (1.10, 2.89)**
		Grab-n-go breakfast (N=364)	SBP participation [OR (95% CI)]	

vs	• All ES students	1.20 (0.95, 1.53)
Traditional SBP (ref) (N=830 schools)	○ Paid students	1.19 (0.77, 1.83)
	○ FRP students	1.18 (0.99, 1.41)
	• All MS students	**1.52 (1.01, 2.28)**
	○ Paid students	**2.20 (1.14, 4.24)**
	○ FRP students	**1.47 (1.09, 1.99)**
	• All HS students	**1.35 (1.05, 1.72)**
	○ Paid students	**1.46 (1.05, 2.03)**
	○ FRP students	**1.37 (1.13, 1.66)**
Second-chance breakfast (N=81)	SBP participation [OR (95% CI)]	
vs	All ES students	1.72 (0.96, 3.10)
Traditional SBP (ref) (N=830 schools)	Paid students	**2.03 (1.10, 3.75)**
	FRP students	1.45 (0.79, 2.68)
	All MS students	**2.61 (1.68, 4.06)**
	Paid students	**4.88 (2.31, 10.30)**
	FRP students	**2.12 (1.54, 2.92)**
	All HS students	**2.27 (1.66, 3.09)**
	Paid students	**2.79 (1.84, 4.23)**
	FRP students	**2.30 (1.61, 3.02)**
BIC + Grab-n-go breakfast (N=186)	SBP participation [OR (95% CI)]	
vs	All ES students	**1.59 (1.23, 2.04)**
Traditional SBP (ref) (N=830 schools)	Paid students	**1.73 (1.11, 2.68)**
	FRP students	**1.50 (1.22, 1.84)**
	All MS students	1.11 (0.96, 1.28)
	Paid students	1.25 (0.98, 1.59)
	FRP students	1.05 (0.96, 1.15)
	All HS students	**1.54 (1.29, 1.84)**
	Paid students	**1.69 (1.42, 2.00)**

	FRP students	**1.43 (1.23, 1.68)**
UFB-BIC (N=284)	SBP participation [OR (95% CI)]	
Vs	All ES students	**2.66 (2.06, 3.44)**
Traditional SBP (ref) (N=830 schools)	Paid students	**3.15 (2.24, 4.42)**
	FRP students	**2.48 (1.95, 3.16)**
	All MS students	**2.47 (1.32, 4.61)**
	Paid students	**4.79 (2.86, 8.02)**
	FRP students	**2.67 (1.45, 4.93)**
	All HS students	**7.42 (4.94, 11.16)**
	Paid students	**6.33 (4.28, 9.36)**
	FRP students	**8.78 (5.86, 13.15)**
UFB + Grab-n-go breakfast (262)	SBP participation [OR (95% CI)]	
vs	All ES students	1.21 (1.00, 1.47)
Traditional SBP (ref) (N=830 schools)	Paid students	1.07 (0.80, 1.43)
	FRP students	1.17 (0.98, 1.41)
	All MS students	1.15 (0.95, 1.40)
	Paid students	0.90 (0.63, 1.29)
	FRP students	1.15 (0.94, 1.41)
	All HS students	1.07 (0.78, 1.48)
	Paid students	0.78 (0.45, 1.33)
	FRP students	1.09 (0.79, 1.51)
UFB + Second-chance breakfast (N=36)	SBP participation [OR (95% CI)]	
vs	All ES students	**2.14 (1.78, 2.57)**
Traditional SBP (ref) (N=830 schools)	Paid students	**1.92 (1.29, 2.85)**
	FRP students	**2.04 (1.75, 2.37)**
	All MS students	**3.61 (2.47, 5.27)**
	Paid students	**4.02 (2.75, 5.86)**
	FRP students	**2.82 (1.87, 4.24)**

			All HS students	**2.39 (1.73, 3.24)**
			Paid students	**2.72 (1.63, 4.53)**
			FRP students	**2.13 (1.64, 2.77)**
		UFB-BIC + Grab-n-go breakfast (N=145) vs Traditional SBP (ref) (N=830 schools)	SBP participation [OR (95% CI)]	
			All ES students	**1.93 (1.46, 2.53)**
			Paid students	**2.50 (1.70, 3.66)**
			FRP students	**1.87 (1.51, 2.31)**
			All MS students	**2.45 (1.07, 5.63)**
			Paid students	**5.91 (1.90, 18.32)**
			FRP students	**2.17 (1.17, 4.00)**
			All HS students	**1.69 (1.17, 2.45)**
			Paid students	**2.16 (1.69, 2.75)**
			FRP students	**1.81 (1.36, 2.43)**
Van Wye, 2013[84] CS ES, grades 3-5 New York, NY	Analytic N: 2,289 students (16 schools) Race/ethnicity: NR SES: conducted "in 3 of NYC's high-need neighborhoods"	UFB-BIC (57 classrooms,1044 students) vs UFB in the cafeteria (67 classrooms, 1245 students)	SBP participation in grades 3-5 (% students)	**70.9 vs 30.9, p<0.001**
			Breakfast skipping in grades 3-5 (% students)	**8.7 vs 15.0, p<0.001**

Table 33: Risk of bias for cluster-randomized controlled trials examining U.S. SBP price and delivery models and SBP participation, breakfast skipping, diet quality, school performance and learning achievement, and measures of body weight[a]

Article and type model assessed (cost or delivery model)	**Randomization**	**Identification of participants-randomization**	**Deviations from intended interventions (effect of assignment or per-protocol)**	**Missing outcome data**	**Outcome measurement**	**Selection of the reported result**
Bauer et al. 2020 [65] Delivery model	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**SOME CONCERNS** Pre-registered protocol did not address study outcomes
Polonsky et al. 2019[68] Delivery model	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**
Crepinsek et al. 2006[69] Cost model	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**SOME CONCERNS** No pre-registered protocol
Hearst et al. 2019[66] Delivery model	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**SOME CONCERNS** Pre-registered protocol did not address study outcomes
Nanney et al. 2019[67] Delivery model	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**

[a] Possible ratings of low, some concerns, or high determined using the "Cochrane Risk-of-bias 2.0" (RoB 2.0) (August 2016 version)" (Higgins JPT, Sterne JAC, Savović J, Page MJ, Hróbjartsson A, Boutron I, Reeves B, Eldridge S. A revised tool for assessing risk of bias in randomized trials In: Chandler J, McKenzie J, Boutron I, Welch V (editors). Cochrane Methods. *Cochrane Database of Systematic Reviews* 2016, Issue 10 (Suppl 1). https://doi.org/10.1002/14651858.CD201601.)

Table 34: Risk of bias for non-randomized studies examining U.S. SBP student cost and delivery models and SBP participation, breakfast skipping, diet quality, school performance and learning achievement, and measures of body weight[a]

Article and type model assessed (cost or delivery model)	**Confounding** (Key confounders: age, sex, race/ethnicity, socioeconomic status, school or cluster characteristics)	**Selection of participants**	**Classification of interventions**	**Deviations from intended interventions**	**Missing data**	**Outcome measurement**	**Selection of the reported result**
Anzman-Frasca et al., 2015[70] Delivery model	**CRITICAL** Key confounder not accounted for: school characteristic/cluster	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**MODERATE** No pre-registered protocol
Bartfeld, 2019[71] Cost and delivery model	**MODERATE** Key confounders not accounted for: None	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**MODERATE** No pre-registered protocol
Corcoran, 2016[72] Delivery model	**MODERATE** Key confounders not accounted for: None	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**MODERATE** No pre-registered protocol
Imberman, 2014[73] Delivery model	**MODERATE** Key confounders not accounted for: None	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**MODERATE** No pre-registered protocol
Leos-Urbel, 2013[74] Cost model	**MODERATE** Key confounders not accounted for: None	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**MODERATE** No pre-registered protocol
Kirksey, 2021[76] Delivery model	**MODERATE** Key confounders not accounted for: None	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**MODERATE** No pre-registered protocol
Ribar, 2013[75] Cost model	**MODERATE** Key confounders not accounted for: None	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**MODERATE** No pre-registered protocol
Schneider, 2021[77]	**CRITICAL** Key confounder not	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**MODERATE** No pre-registered protocol

[a] Possible ratings of low, moderate, serious, critical, or no information determined using the "Risk of Bias in Non-randomized Studies of Interventions (ROBINS-I) tool" (Sterne JAC, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, Henry D, Altman DG, Ansari MT, Boutron I, Carpenter JR, Chan AW, Churchill R, Deeks JJ, Hróbjartsson A, Kirkham J, Jüni P, Loke YK, Pigott TD, Ramsay CR, Regidor D, Rothstein HR, Sandhu L, Santaguida PL, Schünemann HJ, Shea B, Shrier I, Tugwell P, Turner L, Valentine JC, Waddington H, Waters E, Wells GA, Whiting PF, Higgins JPT. ROBINS-I: a tool for assessing risk of bias in non-randomized studies of interventions. BMJ 2016; 355; i4919; https://doi.org/10.1136/bmj.i4919.)

Cost model	accounted for: age/grade, race/ethnicity, SES		

Table 35: Risk of bias for observational studies examining U.S. SBP student cost and delivery models and SBP participation, breakfast skipping, diet quality, school performance and learning achievement, and measures of body weight[a]

Article, study design and type model assessed (cost or delivery model)	**Confounding** (Key confounders: age, sex, race/ethnicity, socioeconomic status, school or cluster characteristics)	**Selection of participants**	**Classification of exposures**	**Deviations from intended exposures**	**Missing data**	**Outcome measurement**	**Selection of the reported result**
Bartfeld, 2010[78] Cross-sectional Delivery model	**MODERATE** Key confounders not accounted for: None	**MODERATE** Sound for an observational study	**MODERATE** Breakfast duration based on parent/admin-istration observation and reporting	**No information**	**LOW**	**LOW**	**MODERATE** No pre-registered protocol
Baxter, 2010[79] Cross-sectional Delivery model	**MODERATE** Key confounders not accounted for: None	**MODERATE** Sound for an observational study	**LOW**	**No information**	**LOW**	**LOW**	**MODERATE** No pre-registered protocol
Grannon, 2020[85] Uncontrolled pre-post Delivery model	**MODERATE** Key confounders not accounted for: None	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**MODERATE** No pre-registered protocol
Guinn, 2013[80] Cross-sectional Delivery model	**SERIOUS** Key confounders not accounted for: school characteristic/cluster	**MODERATE** Sound for an observational study	**LOW**	**No information**	**LOW**	**LOW**	**MODERATE** No pre-registered protocol
Larson, 2018[86] Uncontrolled pre-post Delivery model	**MODERATE** Key confounders not accounted for: None	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**MODERATE** No registered protocol available

[a] Possible ratings of low, moderate, serious, critical, or no information determined using the "Risk of Bias for Nutrition Observational Studies" tool (RoB-NObs) (Dietary Guidelines Advisory Committee. 2020. *Scientific Report of the 2020 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Agriculture and the Secretary of Health and Human Services*. U.S. Department of Agriculture, Agricultural Research Service, Washington, DC.)

Leider, 20 20 [81] Cross-sectional (SBP participation outcome) Cost model	**MODERATE** Key confounders not accounted for: None	**MODERATE** Sound for an observational study	**LOW**	**No information**	**LOW**	**LOW** SBP participation	**MODERATE** No pre-registered protocol
Leider, 2020 [81] Cross-sectional (Liking SBP outcome) Cost model	**MODERATE** Key confounders not accounted for: None	**MODERATE** Sound for an observational study	**LOW**	**No information**	**LOW**	**MODERATE** SBP liking is a subjective assessment	**MODERATE** No registered protocol available
Moeltner, 2018[87] Uncontrolled pre-post Delivery model	**SERIOUS** Key confounders not accounted for: age, race/ethnicity, SES, school or cluster	**MODERATE** Sound for an observational study	**LOW**	**No Information**	**LOW**	**LOW**	**MODERATE** No registered protocol available
Nanney, 2011[88] Uncontrolled pre-post Delivery model	**SERIOUS** Key confounder not accounted for: race/ethnicity	**MODERATE** Sound for an observational study	**LOW**	**LOW**	**LOW**	**LOW**	**MODERATE** No registered protocol available
Ritchie, 2015[82] Cross-sectional Delivery model	**MODERATE** Key confounders not accounted for: None	**MODERATE** Sound for an observational study	**LOW**	**No Information**	**LOW**	**LOW**	**MODERATE** No registered protocol available
Soldavini, 2019[83] Cross-sectional Cost and delivery model	**SERIOUS** Key confounder not accounted for: age/grade, race/ethnicity	**MODERATE** Sound for an observational study	**LOW**	**No information**	**LOW**	**LOW**	**MODERATE** No registered protocol available
Van Wye, 2013[84] Cross-sectional Delivery model	**SERIOUS** Key confounder not accounted for: age/grade, race/ethnicity, SES, school characteristic/cluster	**MODERATE** Sound for an observational study	**SERIOUS** No information on validity of assessment tool	**No information**	**LOW**	**CRITICAL** Self-report	**MODERATE** No registered protocol available

References

1. Pivik RT, Tennal KB, Chapman SD, Gu Y. Eating breakfast enhances the efficiency of neural networks engaged during mental arithmetic in school-aged children. *Physiol Behav.* 2012;106(4):548-555. https://doi.org/10.1016/j.physbeh.2012.03.034.
2. Kawabata M, Lee K, Choo HC, Burns SF. Breakfast and Exercise Improve Academic and Cognitive Performance in Adolescents. *Nutrients.* 2021;13(4). https://doi.org/10.3390/nu13041278.
3. Littlecott HJ, Moore GF, Moore L, Lyons RA, Murphy S. Association between breakfast consumption and educational outcomes in 9-11-year-old children. *Public Health Nutr.* 2016;19(9):1575-1582. https://doi.org/10.1017/S1368980015002669.
4. Ptomey LT, Steger FL, Schubert MM, et al. Breakfast Intake and Composition Is Associated with Superior Academic Achievement in Elementary Schoolchildren. *J Am Coll Nutr.* 2016;35(4):326-333. https://doi.org/10.1080/07315724.2015.1048381.
5. Cooper SB, Bandelow S, Nevill ME. Breakfast consumption and cognitive function in adolescent schoolchildren. *Physiol Behav.* 2011;103(5):431-439. https://doi.org/10.1016/j.physbeh.2011.03.018.
6. Cooper SB, Bandelow S, Nute ML, Morris JG, Nevill ME. Breakfast glycaemic index and cognitive function in adolescent school children. *Br J Nutr.* 2012;107(12):1823-1832. https://doi.org/10.1017/S0007114511005022.
7. Defeyter MA, Russo R. The effect of breakfast cereal consumption on adolescents' cognitive performance and mood. *Front Hum Neurosci.* 2013;7:789. https://doi.org/10.3389/fnhum.2013.00789.
8. Fulford J, Varley-Campbell JL, Williams CA. The effect of breakfast versus no breakfast on brain activity in adolescents when performing cognitive tasks, as assessed by fMRI. *Nutr Neurosci.* 2016;19(3):110-115. https://doi.org/10.1179/1476830515Y.0000000011.
9. Iovino I, Stuff J, Liu Y, et al. Breakfast consumption has no effect on neuropsychological functioning in children: a repeated-measures clinical trial. *Am J Clin Nutr.* 2016;104(3):715-721. https://doi.org/10.3945/ajcn.116.132043.
10. Kral TV, Heo M, Whiteford LM, Faith MS. Effects on cognitive performance of eating compared with omitting breakfast in elementary schoolchildren. *J Dev Behav Pediatr.* 2012;33(1):9-16. https://doi.org/10.1097/DBP.0b013e31823f2f35.
11. Maffeis C, Fornari E, Surano MG, et al. Breakfast skipping in prepubertal obese children: hormonal, metabolic and cognitive consequences. *Eur J Clin Nutr.* 2012;66(3):314-321. https://doi.org/10.1038/ejcn.2011.206.
12. Mahoney CR, Taylor HA, Kanarek RB, Samuel P. Effect of breakfast composition on cognitive processes in elementary school children. *Physiol Behav.* 2005;85(5):635-645. https://doi.org/10.1016/j.physbeh.2005.06.023.
13. Widenhorn-Müller K, Hille K, Klenk J, Weiland U. Influence of having breakfast on cognitive performance and mood in 13- to 20-year-old high school students: results of a crossover trial. *Pediatrics.* 2008;122(2):279-284. https://doi.org/10.1542/peds.2007-0944.
14. Adolphus K, Hoyland A, Walton J, Quadt F, Lawton CL, Dye L. Ready-to-eat cereal and milk for breakfast compared with no breakfast has a positive acute effect on cognitive function and subjective state in 11-13-year-olds: a school-based, randomised, controlled, parallel groups trial. *Eur J Nutr.* 2021;60(6):3325-3342. https://doi.org/10.1007/s00394-021-02506-2.
15. Zipp A, Eissing G. Studies on the influence of breakfast on the mental performance of school children and adolescents. *Journal of Public Health: From Theory to Practice.* 2019;27:103-110. https://doi.org/10.1007/s10389-018-0926-4.
16. Smith A. An investigation of the effects of breakfast cereals on alertness, cognitive function and other aspects of the reported well-being of children. *Nutritional Neuroscience.* 2010;13(5). https://doi.org/10.1179/147683010X12611460764642.
17. Liu J, Wu L, Um P, et al. Breakfast Consumption Habits at Age 6 and Cognitive Ability at Age 12: A Longitudinal Cohort Study. *Nutrients.* 2021;13(6). https://doi.org/10.3390/nu13062080.
18. Wesnes KA, Pincock C, Scholey A. Breakfast is associated with enhanced cognitive function in schoolchildren. An internet based study. *Appetite.* 2012;59(3):646-649.

https://doi.org/10.1016/j.appet.2012.08.008.
19. Benton D, Jarvis M. The role of breakfast and a mid-morning snack on the ability of children to concentrate at school. *Physiol Behav.* 2007;90(2-3):382-385. https://doi.org/10.1016/j.physbeh.2006.09.029.
20. Pena-Jorquera H, Campos-Nunez V, Sadarangani KP, Ferrari G, Jorquera-Aguilera C, Cristi-Montero C. Breakfast: A Crucial Meal for Adolescents' Cognitive Performance According to Their Nutritional Status. The Cogni-Action Project. *Nutrients.* 2021;13(4). https://doi.org/10.3390/nu13041320.
21. Affenito SG, Thompson DR, Barton BA, et al. Breakfast consumption by African-American and white adolescent girls correlates positively with calcium and fiber intake and negatively with body mass index. *J Am Diet Assoc.* 2005;105(6):938-945. https://doi.org/10.1016/j.jada.2005.03.003.
22. Albertson AM, Franko DL, Thompson D, et al. Longitudinal patterns of breakfast eating in black and white adolescent girls. *Obesity (Silver Spring).* 2007;15(9):2282-2292. https://doi.org/10.1038/oby.2007.271.
23. Barton BA, Eldridge AL, Thompson D, et al. The relationship of breakfast and cereal consumption to nutrient intake and body mass index: the National Heart, Lung, and Blood Institute Growth and Health Study. *J Am Diet Assoc.* 2005;105(9):1383-1389. https://doi.org/10.1016/j.jada.2005.06.003.
24. Carlson JA, Crespo NC, Sallis JF, Patterson RE, Elder JP. Dietary-related and physical activity-related predictors of obesity in children: a 2-year prospective study. *Child Obes.* 2012;8(2):110-115. https://doi.org/10.1089/chi.2011.0071.
25. Cayres SU, Urban JB, Fernandes RA. Physical Activity and Skipping Breakfast Have Independent Effects on Body Fatness Among Adolescents. *J Pediatr Gastroenterol Nutr.* 2018;67(5):666-670. https://doi.org/10.1097/MPG.0000000000002081.
26. Chang Y, Gable S. Predicting weight status stability and change from fifth grade to eighth grade: the significant role of adolescents' social-emotional well-being. *J Adolesc Health.* 2013;52(4):448-455. https://doi.org/10.1016/j.jadohealth.2012.09.005.
27. Crossman A, Anne Sullivan D, Benin M. The family environment and American adolescents' risk of obesity as young adults. *Soc Sci Med.* 2006;63(9):2255-2267. https://doi.org/10.1016/j.socscimed.2006.05.027.
28. de Winter AF, Visser L, Verhulst FC, Vollebergh WA, Reijneveld SA. Longitudinal patterns and predictors of multiple health risk behaviors among adolescents: The TRAILS study. *Prev Med.* 2016;84:76-82. https://doi.org/10.1016/j.ypmed.2015.11.028.
29. Elgar FJ, Roberts C, Moore L, Tudor-Smith C. Sedentary behaviour, physical activity and weight problems in adolescents in Wales. *Public Health.* 2005;119(6):518-524. https://doi.org/10.1016/j.puhe.2004.10.011.
30. Gingras V, Rifas-Shiman SL, Taveras EM, Oken E, Hivert MF. Dietary behaviors throughout childhood are associated with adiposity and estimated insulin resistance in early adolescence: a longitudinal study. *Int J Behav Nutr Phys Act.* 2018;15(1):129. https://doi.org/10.1186/s12966-018-0759-0.
31. Goff LM, Huang P, Silva MJ, et al. Associations of dietary intake with cardiometabolic risk in a multi-ethnic cohort: a longitudinal analysis of the Determinants of Adolescence, now young Adults, Social well-being and Health (DASH) study. *Br J Nutr.* 2019;121(9):1069-1079. https://doi.org/10.1017/S0007114519000291.
32. Haerens L, Vereecken C, Maes L, De Bourdeaudhuij I. Relationship of physical activity and dietary habits with body mass index in the transition from childhood to adolescence: a 4-year longitudinal study. *Public Health Nutr.* 2010;13(10A):1722-1728. https://doi.org/10.1017/S1368980010002284.
33. Haines J, Neumark-Sztainer D, Wall M, Story M. Personal, behavioral, and environmental risk and protective factors for adolescent overweight. *Obesity (Silver Spring).* 2007;15(11):2748-2760. https://doi.org/10.1038/oby.2007.327.
34. Hassan BK, Cunha DB, da Veiga GV, Pereira RA, Hoffman DJ, Sichieri R. Breakfast Consumption, Family Breakfast, and Adiposity Trajectory in Adolescence-The Adolescent Nutritional Assessment Longitudinal Cohort Study. *J Acad Nutr Diet.* 2019;119(6):944-956. https://doi.org/10.1016/j.jand.2018.11.014.
35. Kelly Y, Patalay P, Montgomery S, Sacker A. BMI Development and Early Adolescent Psychosocial

Well-Being: UK Millennium Cohort Study. *Pediatrics.* 2016;138(6). https://doi.org/10.1542/peds.2016-0967.
36. Kesztyus D, Lauer R, Kesztyus T, Kilian R, Steinacker JM, Join the Healthy Boat" Study G. Costs and effects of a state-wide health promotion program in primary schools in Germany - the Baden-Wurttemberg Study: A cluster-randomized, controlled trial. *PLoS One.* 2017;12(2):e0172332. https://doi.org/10.1371/journal.pone.0172332.
37. Kesztyus D, Traub M, Lauer R, Kesztyus T, Steinacker JM. Correlates of longitudinal changes in the waist-to-height ratio of primary school children: Implications for prevention. *Prev Med Rep.* 2016;3:1-6. https://doi.org/10.1016/j.pmedr.2015.11.005.
38. Kim HS, Jung SJ, Mun EG, Kim MS, Cho SM, Cha YS. Effects of a Rice-Based Diet in Korean Adolescents Who Habitually Skip Breakfast: A Randomized, Parallel Group Clinical Trial. *Nutrients.* 2021;13(3). https://doi.org/10.3390/nu13030853.
39. Laska MN, Murray DM, Lytle LA, Harnack LJ. Longitudinal associations between key dietary behaviors and weight gain over time: transitions through the adolescent years. *Obesity (Silver Spring).* 2012;20(1):118-125. https://doi.org/10.1038/oby.2011.179.
40. Lee H, Harris KM, Gordon-Larsen P. Life Course Perspectives on the Links Between Poverty and Obesity During the Transition to Young Adulthood. *Popul Res Policy Rev.* 2009;28(4):505-532. https://doi.org/10.1007/s11113-008-9115-4.
41. Liechty JM, Lee MJ. Body size estimation and other psychosocial risk factors for obesity onset among US adolescents: findings from a longitudinal population level study. *Int J Obes (Lond).* 2015;39(4):601-607. https://doi.org/10.1038/ijo.2014.191.
42. Lipsky LM, Haynie DL, Liu D, et al. Trajectories of eating behaviors in a nationally representative cohort of U.S. adolescents during the transition to young adulthood. *Int J Behav Nutr Phys Act.* 2015;12:138. https://doi.org/10.1186/s12966-015-0298-x.
43. MacFarlane A, Cleland V, Crawford D, Campbell K, Timperio A. Longitudinal examination of the family food environment and weight status among children. *Int J Pediatr Obes.* 2009;4(4):343-352. https://doi.org/10.3109/17477160902846211.
44. Merten MJ, Williams AL, Shriver LH. Breakfast consumption in adolescence and young adulthood: parental presence, community context, and obesity. *J Am Diet Assoc.* 2009;109(8):1384-1391. https://doi.org/10.1016/j.jada.2009.05.008.
45. Miller DP. Associations between the home and school environments and child body mass index. *Soc Sci Med.* 2011;72(5):677-684. https://doi.org/10.1016/j.socscimed.2010.12.003.
46. Niemeier HM, Raynor HA, Lloyd-Richardson EE, Rogers ML, Wing RR. Fast food consumption and breakfast skipping: predictors of weight gain from adolescence to adulthood in a nationally representative sample. *J Adolesc Health.* 2006;39(6):842-849. https://doi.org/10.1016/j.jadohealth.2006.07.001.
47. Okada C, Tabuchi T, Iso H. Association between skipping breakfast in parents and children and childhood overweight/obesity among children: a nationwide 10.5-year prospective study in Japan. *Int J Obes (Lond).* 2018;42(10):1724-1732. https://doi.org/10.1038/s41366-018-0066-5.
48. Quick V, Wall M, Larson N, Haines J, Neumark-Sztainer D. Personal, behavioral and socio-environmental predictors of overweight incidence in young adults: 10-yr longitudinal findings. *Int J Behav Nutr Phys Act.* 2013;10:37. https://doi.org/10.1186/1479-5868-10-37.
49. Shang X, Li Y, Xu H, et al. Healthy breakfast habits and changes in obesity-related cardiometabolic markers in children: a longitudinal analysis. *Eur J Clin Nutr.* 2020;74(12):1685-1697. https://doi.org/10.1038/s41430-020-0614-7.
50. Smith KJ, Gall SL, McNaughton SA, Blizzard L, Dwyer T, Venn AJ. Skipping breakfast: longitudinal associations with cardiometabolic risk factors in the Childhood Determinants of Adult Health Study. *Am J Clin Nutr.* 2010;92(6):1316-1325. https://doi.org/10.3945/ajcn.2010.30101.
51. Sudharsanan N, Romano S, Cunningham SA. School Breakfast Receipt and Obesity among American Fifth- and Eighth-Graders. *J Acad Nutr Diet.* 2016;116(4):599-607 e593. https://doi.org/10.1016/j.jand.2015.08.021.
52. Thompson OM, Ballew C, Resnicow K, et al. Dietary pattern as a predictor of change in BMI z-score

among girls. *Int J Obes (Lond).* 2006;30(1):176-182. https://doi.org/10.1038/sj.ijo.0803072.
53. Timlin MT, Pereira MA, Story M, Neumark-Sztainer D. Breakfast eating and weight change in a 5-year prospective analysis of adolescents: Project EAT (Eating Among Teens). *Pediatrics.* 2008;121(3):e638-645. https://doi.org/10.1542/peds.2007-1035.
54. Tin SP, Ho SY, Mak KH, Wan KL, Lam TH. Breakfast skipping and change in body mass index in young children. *Int J Obes (Lond).* 2011;35(7):899-906. https://doi.org/10.1038/ijo.2011.58.
55. Tin SP, Ho SY, Mak KH, Wan KL, Lam TH. Location of breakfast consumption predicts body mass index change in young Hong Kong children. *Int J Obes (Lond).* 2012;36(7):925-930. https://doi.org/10.1038/ijo.2011.262.
56. Traub M, Lauer R, Kesztyus T, et al. Skipping breakfast, overconsumption of soft drinks and screen media: longitudinal analysis of the combined influence on weight development in primary schoolchildren. *BMC Public Health.* 2018;18(1):363. https://doi.org/10.1186/s12889-018-5262-7.
57. Wang S, Schwartz MB, Shebl FM, Read M, Henderson KE, Ickovics JR. School breakfast and body mass index: a longitudinal observational study of middle school students. *Pediatr Obes.* 2017;12(3):213-220. https://doi.org/10.1111/ijpo.12127.
58. Wennberg M, Gustafsson PE, Wennberg P, Hammarstrom A. Poor breakfast habits in adolescence predict the metabolic syndrome in adulthood. *Public Health Nutr.* 2015;18(1):122-129. https://doi.org/10.1017/S1368980013003509.
59. Leidy HJ, Racki EM. The addition of a protein-rich breakfast and its effects on acute appetite control and food intake in 'breakfast-skipping'adolescents. *International journal of obesity.* 2010;34(7):1125-1133. https://doi.org/10.1038/ijo.2010.3.
60. Kim N, Seo D-C, King MH, Lederer AM, Sovinski D. Long-term predictors of blood pressure among adolescents during an 18-month school-based obesity prevention intervention. *Journal of Adolescent Health.* 2014;55(4):521-527. https://doi.org/10.1016/j.jadohealth.2014.04.011.
61. Meyer U, Schindler C, Bloesch T, et al. Combined impact of negative lifestyle factors on cardiovascular risk in children: a randomized prospective study. *Journal of adolescent health.* 2014;55(6):790-795. https://doi.org/10.1016/j.jadohealth.2014.07.007.
62. Zaqout M, Vyncke K, Moreno LA, et al. Determinant factors of physical fitness in European children. *International journal of public health.* 2016;61(5):573-582.
63. Chen X, Sekine M, Hamanishi S, Yamagami T, Kagamimori S. Associations of lifestyle factors with quality of life (QOL) in Japanese children: a 3-year follow-up of the Toyama Birth Cohort Study. *Child: care, health and development.* 2005;31(4):433-439. https://doi.org/10.1111/j.1365-2214.2005.00529.x.
64. Gong W-J, Fong DY-T, Wang M-P, Lam T-H, Chung TW-H, Ho S-Y. Skipping breakfast and eating breakfast away from home were prospectively associated with emotional and behavioral problems in 115,217 Chinese adolescents. *Journal of epidemiology.* 2021:JE20210081. https://doi.org/10.2188/jea.JE20210081.
65. Bauer KW, Foster GD, Weeks HM, et al. Breakfast in the Classroom Initiative and Students' Breakfast Consumption Behaviors: A Group Randomized Trial. *Am J Public Health.* 2020;110(4):540-546. https://doi.org/10.2105/AJPH.2019.305511.
66. Hearst MO, Jimbo-Llapa F, Grannon K, Wang Q, Nanney MS, Caspi CE. Breakfast Is Brain Food? The Effect on Grade Point Average of a Rural Group Randomized Program to Promote School Breakfast. *J Sch Health.* 2019;89(9):715-721. https://doi.org/10.1111/josh.12810.
67. Nanney MS, Leduc R, Hearst M, et al. A Group Randomized Intervention Trial Increases Participation in the School Breakfast Program in 16 Rural High Schools in Minnesota. *J Acad Nutr Diet.* 2019;119(6):915-922. https://doi.org/10.1016/j.jand.2018.12.007.
68. Polonsky HM, Bauer KW, Fisher JO, et al. Effect of a Breakfast in the Classroom Initiative on Obesity in Urban School-aged Children: A Cluster Randomized Clinical Trial. *JAMA Pediatr.* 2019;173(4):326-333. https://doi.org/10.1001/jamapediatrics.2018.5531.
69. Crepinsek MK, Singh A, Bernstein LS, McLaughlin JE. Dietary effects of universal-free school breakfast: findings from the evaluation of the school breakfast program pilot project. *J Am Diet Assoc.* 2006;106(11):1796-1803. https://doi.org/10.1016/j.jada.2006.08.013.
70. Anzman-Frasca S, Djang HC, Halmo MM, Dolan PR, Economos CD. Estimating impacts of a breakfast

in the classroom program on school outcomes. *JAMA Pediatr.* 2015;169(1):71-77. https://doi.org/10.1001/jamapediatrics.2014.2042.
71. Bartfeld JS, Berger L, Men F, Chen Y. Access to the School Breakfast Program Is Associated with Higher Attendance and Test Scores among Elementary School Students. *J Nutr.* 2019;149(2):336-343. https://doi.org/10.1093/jn/nxy267.
72. Corcoran SP, Elbel B, Schwartz AE. The Effect of Breakfast in the Classroom on Obesity and Academic Performance: Evidence from New York City. *J Policy Anal Manage.* 2016;35(3):509-532. https://doi.org/10.1002/pam.21909.
73. Imberman SA, Kugker AD. The Effect of Providing Breakfast in Class on Student Performance. *Journal of Policy Analysis and Management.* 2014;33(3):669-699. https://onlinelibrary.wiley.com/doi/full/10.1002/pam.21759.
74. Leos-Urbel J, Schwartz AE, Weinstein M, Corcoran S. Not just for poor kids: The impact of universal free school breakfast on meal participation and student outcomes. *Econ Educ Rev.* 2013;36:88-107. https://doi.org/10.1016/j.econedurev.2013.06.007.
75. Ribar DC, Haldeman LA. Changes in Meal Participation, Attendance, and Test Scores Associated with the Availability of Universal Free School Breakfasts. *Social Service Review.* 2013;87(2):354-385. https://doi.org/10.1086/671013.
76. Kirksey JJ, Gottfried MA. The Effect of Serving “Breakfast After-the-Bell” Meals on School Absenteeism: Comparing Results From Regression Discontinuity Designs. *Educational Evaluation and Policy Analysis.* 2021;43(2):305-328. https://doi.org/10.3102/0162373721991572.
77. Schneider KR, Oslund J, Liu T. Impact of the community eligibility provision program on school meal participation in Texas. *Public Health Nutr.* 2021;24(18):6534-6542. https://doi.org/10.1017/S1368980021003712.
78. Bartfeld J, Kim M. Participation in the School Breakfast Program: new evidence from the ECLS-K. *Soc Serv Rev.* 2010;84(4):541-562. https://doi.org/10.1086/657109.
79. Baxter SD, Hardin JW, Guinn CH, Royer JA, Mackelprang AJ, Devlin CM. Children's body mass index, participation in school meals, and observed energy intake at school meals. *Int J Behav Nutr Phys Act.* 2010;7:24. https://doi.org/10.1186/1479-5868-7-24.
80. Guinn CH, Baxter SD, Finney CJ, Hitchcock DB. Examining variations in fourth-grade children's participation in school-breakfast and school-lunch programs by student and program demographics. *J Child Nutr Manag.* 2013;37(1):5. https://www.ncbi.nlm.nih.gov/pubmed/24701197. Published 2013/01/01.
81. Leider J, Lin W, Piekarz-Porter E, Turner L, Chriqui JF. The Role of District Wellness Policies in Encouraging Student Participation in the School Breakfast Program, United States. *Nutrients.* 2020;12(8). https://doi.org/10.3390/nu12082187.
82. Ritchie LD, Rosen NJ, Fenton K, Au LE, Goldstein LH, Shimada T. School Breakfast Policy Is Associated with Dietary Intake of Fourth- and Fifth-Grade Students. *J Acad Nutr Diet.* 2016;116(3):449-457. https://doi.org/10.1016/j.jand.2015.08.020.
83. Soldavini J, Ammerman AS. Serving Breakfast Free to All Students and Type of Breakfast Serving Model Are Associated with Participation in the School Breakfast Program. *J Acad Nutr Diet.* 2019;119(7):1142-1149. https://doi.org/10.1016/j.jand.2019.03.001.
84. Van Wye G, Seoh H, Adjoian T, Dowell D. Evaluation of the New York City breakfast in the classroom program. *Am J Public Health.* 2013;103(10):e59-64. https://doi.org/10.2105/AJPH.2013.301470.
85. Grannon KY, Nanney MS, Wang Q, et al. Do High School Students Participate in Second Chance Breakfast Programs? *J Sch Health.* 2020;90(2):119-126. https://doi.org/10.1111/josh.12857.
86. Larson N, Wang Q, Grannon K, Wei S, Nanney MS, Caspi C. A Low-Cost, Grab-and-Go Breakfast Intervention for Rural High School Students: Changes in School Breakfast Program Participation Among At-Risk Students in Minnesota. *J Nutr Educ Behav.* 2018;50(2):125-132 e121. https://doi.org/10.1016/j.jneb.2017.08.001.
87. Moeltner K, Spears K, Ling Y. Breakfast at School: A First Look at the Role of Time and Location for Participation and Nutritional Intake. *American Journal of Agricultural Economics.* 2019;101(1):39-57. http://dx.doi.org/10.1093/ajae/aay048.

88. Nanney MS, Olaleye TM, Wang Q, Motyka E, Klund-Schubert J. A pilot study to expand the school breakfast program in one middle school. *Transl Behav Med.* 2011;1(3):436-442. https://doi.org/10.1007/s13142-011-0068-5.

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The review team and collaborators developed the initial rapid review protocol (September 2018). GB developed the literature search. BJK, RR, DG, CD, and JMS screened search results, identified articles for inclusion, extracted data from and assessed the risk of bias of the included studies, synthesized the evidence, and developed summary statements and research recommendations. RR, BJK, and DG led Key Questions 1a, 1b, and 1c, respectively. CD led Key Question 2 prior to May 2019, and JMS led the update of Key Question 2 in 2021. JMS provided oversight of the project and has primary responsibility for final content. The authors declare no conflict of interest.

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Appendix 1: Abbreviations

Table A1 1. Abbreviations from Key Question 1a: What is the relationship between eating breakfast and school performance?

Abbreviation	Meaning
BMI	Body Mass index
CHO	Carbohydrate
CPT	Continuous Performance Test
DSM-5	Diagnostic and Statistical Manual of Mental Disorders, fifth edition
FSM	Free School Meal
GI	Glycemic Index
HDI	Human Development Index
IQ	Intelligence Quotient
LGT3	Lern- und Gedaechtnistest
RCT	Randomized controlled trial
RTEC	Ready-to-eat-cereal
SES	Socio-economic status
TOMAL	The Test of Memory and Learning
USDA	U.S. Department of Agriculture
WIAT	Wechsler Individual Achievement Test
WISC	Wechsler Intelligence Scale for Children
WRAT	Wide Range Achievement Test
WRAML	Wide Range Assessment of Memory and Learning

Table A1 2. Abbreviations from Key Question 1b: What is the relationship between eating breakfast and weight-related outcomes?

Abbreviation	Meaning
BMI	Body Mass Index
kcal	Kilocalories
NESR	Nutrition Evidence Systematic Review
SES	Socioeconomic status

Table A1 3. Abbreviationsfrom Key Question 1c: What is the relationship between eating breakfast and health?

Abbreviation	Meaning
AUC	Area under the curve
BMI	Body mass index
cm	Centimeters
g	Grams
GLP-1	Glucagon-like peptide-1
HDL	High-density lipoprotein
HOMA-IR	Homeostasis model of insulin resistance
kcal	Kilocalories
kj	Kilojoules
LDL	Low-density lipoprotein
m	Meters
mL	Milliliters
mm	Millimeters
mmHg	Millimeters of mercury
mmol/L	Millimoles per liter
PYY	Peptide YY
SES	Socioeconomic status
VO_{2max}	Maximal oxygen consumption

Table A1 4. Abbreviations from Key Question 2: What best practices exist in the U.S. School Breakfast Program, including models of student costs and breakfast delivery?

Abbreviation	**Meaning**
BAB	Breakfast-after-the-bell
BIC	Breakfast in the classroom
BMI	Body Mass index
CEP	Community Eligibility Provision
ES	Elementary school
FRP	Free- or reduced-price
GPA	Grade point average
HEI	Healthy Eating Index
HS	High school
K	Kindergarten
MS	Middle school
NESR	Nutrition Evidence Synthesis Review
NRCT	Randomized controlled trial
RCT	Non-randomized controlled trial
SCB	Second chance breakfast
SES	Socioeconomic status
SNAP-Ed	Supplemental Nutrition Assistance Program Education
UFB	Universal free breakfast

Appendix 2: Excluded articles

The following tables list the articles excluded from the rapid reviews during full-text screening. At least one reason for exclusion is provided for each article, though this may not reflect all possible reasons. Information about articles excluded after title and abstract screening is available upon request.

Table A2 1. Articles excluded during full-text screening of the initial literature search for Key Question 1a: What is the relationship between eating breakfast and school performance?

Article	Reason for exclusion
Mhurchu, C. N., Gorton, D., Turley, M., Jiang, Y., Michie, J., Maddison, R., & Hattie, J. (2013). Effects of a free school breakfast programme on children's attendance, academic achievement, and short-term hunger: Results from a stepped-wedge, cluster randomised controlled trial. *Journal of Epidemiology & Community Health, 67* (3), 257-264. http://doi.org/10.1136/jech-2012-201540	Publication status
Pivik, R. T., Tennal, K. B., Chapman, S. D., & Gu, Y. (2012). Eating breakfast enhances the efficiency of neural networks engaged during mental arithmetic in school-aged children. *Physiology & Behavior, 106* (4), 548-555. https://doi.org/10.1016/j.physbeh.2012.03.034	Publication status
Effects of Breakfast on Cognitive Processes in Children. (2010). NCT01063894. Retrieved from https://clinicaltrials.gov/show/nct01063894	Publication status
Nutrition Intervention to Measure Metabolic Response in Children. (2017). NCT03139773. Retrieved from https://clinicaltrials.gov/show/nct03139773	Publication status
The Effects of Breakfast on Brain Function. (2008). NCT00621595. Retrieved from https://clinicaltrials.gov/ct2/show/nct00621595	Publication status
The Influence of Breakfast on Hormone Responses and Cognitive Performance.(2016). NCT03005951. Retrieved from https://clinicaltrials.gov/show/nct03005951	Publication status
Ahmadi, A., Sohrabi, Z., & Eftekhari, M. H. (2009). Evaluating the relationship between breakfast pattern and short-term memory in junior high school girls. *Pakistan Journal of Biological Sciences, 12* (9), 712-715. http://doi.org/10.3923/pjbs.2009.742.745	Intervention, exposure, or comparator
Anzman-Frasca, S., Djang, H. C., Halmo, M. M., Dolan, P. R., & Economos, C. D. (2015). Estimating impacts of a breakfast in the classroom program on school outcomes. *JAMA Pediatrics, 169* (1), 71-77. http://doi.org/10.1001/jamapediatrics.2014.2042	Intervention, exposure, or comparator
Benton, D., Maconie, A., & Williams, C. (2007). The influence of the glycaemic load of breakfast on the behaviour of children in school. *Physiology & Behavior, 92* (4), 717-724. https://doi.org/10.1016/j.physbeh.2007.05.065	Intervention, exposure, or comparator
Chaplin, K., & Smith, A. P. (2011). Breakfast and snacks: Associations with cognitive failures, minor injuries, accidents and stress. *Nutrients, 3* (5), 515-528. https://doi.org/10.3390/nu3050515	Intervention, exposure, or comparator
Corcoran, S. P., Elbel, B., & Schwartz, A. E. (2016). The effect of breakfast in the classroom on obesity and academic performance: Evidence from New York City. *Journal of Policy Analysis and Management Volume, 35* (3), 509-532. https://doi.org/10.1002/pam.21909	Intervention, exposure, or comparator
Faught, E. L., Gleddie, D., Storey, K. E., Davison, C. M., & Veugelers, P. J. (2017). Healthy lifestyle behaviours are positively and independently associated with academic achievement: An analysis of self-reported data from a nationally representative sample of Canadian early adolescents. *PLoS One, 12* (7), e0181938-e0181952. https://doi.org/10.1371/journal.pone.0181938	Intervention, exposure, or comparator

Frisvold, D. E. (2015). Nutrition and cognitive achievement: An evaluation of the School Breakfast Program. *Journal of Public Economics, 124*, 91-104. https://doi.org/10.1016/j.jpubeco.2014.12.003	Intervention, exposure, or comparator
Leos-Urbel, J., Schwartz, A. E., Weinstein, M., & Corcoran, S. (2013). Not just for poor kids: The impact of universal free school breakfast on meal participation and student outcomes. *Economics of Education Review, 36*, 88-107. https://doi.org/10.1016/j.econedurev.2013.06.007	Intervention, exposure, or comparator
Mhurchu, C. N., Gorton, D., Turley, M., Jiang, Y., Michie, J., Maddison, R., & Hattie, J. (2013). Effects of a free school breakfast programme on children's attendance, academic achievement, and short-term hunger: Results from a stepped-wedge, cluster randomised controlled trial. *Journal of Epidemiology & Community Health, 67* (3), 257-264. http://doi.org/10.1136/jech-2012-201540	Intervention, exposure, or comparator
Micha, R., Rogers, P. J., Nelson, M. (2011). Glycaemic index and glycaemic load of breakfast predict cognitive function and mood in school children: A randomised controlled trial. *British Journal of Nutrition, 106* (10), 1552-1561. https://doi.org/10.1017/S0007114511002303	Intervention, exposure, or comparator
Skogheim, T. S., Vollrath, M. E. (2015). Associations of child temperament with child overweight and breakfast habits: A population study in five-year-olds. *Nutrients, 7* (12), 10116-10128. http://doi.org/10.3390/nu7125522	Intervention, exposure, or comparator
So W. Y. (2013). Association between frequency of breakfast consumption and academic performance in healthy Korean adolescents. *Iranian Journal of Public Health, 42* (1), 25-32. PMID: 23514747	Intervention, exposure, or comparator
Stea, T. H., & Torstveit, M. K. (2014). Association of lifestyle habits and academic achievement in Norwegian adolescents: A cross-sectional study. *BMC Public Health, 14* (829). https://doi.org/10.1186/1471-2458-14-829	Intervention, exposure, or comparator
Stroebele N, McNally J, Plog A, Siegfried S, Hill JO. (2013). The association of self-reported sleep, weight status, and academic performance in fifth-grade students. *Journal of School Health, 83* (2), 77-84. https://doi.org/10.1111/josh.12001	Intervention, exposure, or comparator
Tanihata, T., Kanda, H., Osaki, Y., Ohida, T., Minowa, M., Wada, K., … Hayashi, K. (2015). Unhealthy lifestyle, poor mental health, and its correlation among adolescents: A nationwide cross-sectional survey. *Asia Pacific Journal of Public Health, 27* (2), NP1557–NP1565. https://doi.org/10.1177/1010539512452753	Intervention, exposure, or comparator
Tapper, K., Murphy, S., Lynch, R., Clark, R., Moore, G. F., & Moore, L. (2007). Development of a scale to measure 9–11-year-olds’ attitudes towards breakfast. European Journal of Clinical Nutrition, 62 (4), 511-518. http://doi.org/10.1038/sj.ejcn.1602735	Intervention, exposure, or comparator
Torres, M., Carmona, I., Campillo, C., Pérez, G., & Campillo, J. E. (2007). Breakfast, plasma glucose and β-hydroxybutyrate, body mass index and academic performance in children from Extremadura, Spain. *Nutrición Hospitalaria, 22* (4), 487-490. PMID: 17650890	Intervention, exposure, or comparator
Veldwijk, J. , Fries, M. C., Bemelmans, W. J., Haveman-Nies, A. , Smit, H. A., Koppelman, G. H. and Wijga, A. H. (2012). Overweight and school performance among primary school children: The PIAMA birth cohort study. *Obesity, 20* (3): 590-596. http://doi.org/10.1038/oby.2011.327	Intervention, exposure, or comparator
Amiri, F., Amani, R., Rashidkhani, B., Khajemogahi, N., Wesnes, K., & Saxby, B. (2008). Effect of breakfast composition on memory of primary school children in Ahwaz. *Iranian Journal of Endocrinology & Metabolism, 10* (3), 247-256.	Publication language
Lozano, R. H., & Ballesteros, J. C. F. (2006). A study on breakfast and school performance in a group of adolescents. *Nutricion Hospitalaria, 21* (3), 346-352. PMID: 16771116	Publication language
Morales, I. F., Vilas, M. V. A., Vega, C. J. M., & Para, M. C. M. (2008). Relation between the breakfast quality and the academic performance in adolescents of Guadalajara (Castilla-La Mancha). *Nutricion Hospitalaria, 23* (4), 383-387. PMID: 18604325	Publication language
Ahadi, Z., Kelishadi, R., Qorbani, M., Zahedi, H., Aram, M., Motlagh, M. E., Ardalan, G., Shafiee, G., Arzaghi, S. M., Asayesh, H., & Heshmat, R. (2016). Association of breakfast intake with psychiatric	Outcome

distress and violent behaviors in Iranian children and adolescents: The CASPIAN- IV study. *The Indian Journal of Pediatrics, 83* (9), 922-929. https://doi.org/10.1007/s12098-016-2049-7	
Baldinger, N., Krebs, A., Muller, R., & Aeberli, I. (2012). Swiss children consuming breakfast regularly have better motor functional skills and are less overweight than breakfast skippers. *Journal of the American College of Nutrition, 31* (2), 87-93. https://doi.org/10.1080/07315724.2012.10720013	Outcome
Boschloo, A., Ouwehand, C., Dekker, S., Lee, N., de Groot, R., Krabbendam, L., Jolles, J. (2012). The relation between breakfast skipping and school performance in adolescents. *Mind, Brain, and Education, 6* (2) 82-88. https://doi.org/10.1111/j.1751-228X.2012.01138.x	Outcome
Hashemi, F. S., Soltani, R., Hassanzadeh, A., & Eslami, A. A. (2017). Relationship between breakfast consumption and self-efficacy, outcome expectations, evaluation and knowledge in elementary students. *International Journal of Pediatrics, 5* (1), 4163-4174. http://doi.org/10.22038/ijp.2016.7678	Outcome
Lee, G., Han, K., & Kim, H. (2017). Risk of mental health problems in adolescents skipping meals: The Korean National Health and Nutrition Examination Survey 2010 to 2012. *Nursing Outlook, 65* (4), 411-419. https://doi.org/10.1016/j.outlook.2017.01.007	Outcome
Lien, L. (2007). Is breakfast consumption related to mental distress and academic performance in adolescents? *Public Health Nutrition, 10* (4), 422-428. https://doi.org/10.1017/S1368980007258550	Outcome
O'Sullivan, T. A., Robinson, M., Kendall, G. E., Miller, M., Jacoby, P., Silburn, S. R., Oddy, W. H. (2009). A good-quality breakfast is associated with better mental health in adolescence. *Public Health Nutrition, 12* (2), 249-258. https://doi.org/10.1017/S1368980008003935	Outcome
Richards, G., Smith, A. P. (2016). Breakfast and energy drink consumption in secondary school children: Breakfast omission, in isolation or in combination with frequent energy drink use, is associated with stress, anxiety, and depression cross-sectionally, but not at 6-month follow-up. *Frontiers in Psychology, 7* (106), 1-10. https://doi.org/10.3389/fpsyg.2016.00106	Outcome
Mhurchu, C. N., Turley, M., Gorton, D., Jiang, Y., Michie, J., Maddison, R., & Hattie, J. (2010). Effects of a free school breakfast programme on school attendance, achievement, psychosocial function, and nutrition: a stepped wedge cluster randomised trial. BMC Public Health, 10 (1), 738-743. http://doi.org/10.1186/1471-2458-10-738	Study design
Adolphus, K., Lawton, C. L., & Dye, L. (2015). The Relationship between Habitual Breakfast Consumption Frequency and Academic Performance in British Adolescents. *Frontiers in Public Health*, *3* (68), 1-10. https://doi.org/10.3389/fpubh.2015.00068	Study design
Edwards, J. U., Mauch, L., Winkelman, M. R. (2011). Relationship of nutrition and physical activity behaviors and fitness measures to academic performance for sixth graders in a midwest city school district. *Journal of School Health, 81* (2), 65-73. https://doi.org/10.1111/j.1746-1561.2010.00562.x	Study design
Hjorth, M. F., Sorensen, L. B., Andersen, R., Dyssegaard, C. B., Ritz, C., Tetens, I., Michaelsen, K. F., Astrup, A., Egelund, N., & Sjodin, A. (2016). Normal weight children have higher cognitive performance - Independent of physical activity, sleep, and diet. *Physiology & Behavior, 165* (2016), 398-404. https://doi.org/10.1016/j.physbeh.2016.08.021	Study design
Ho, C. Y., Huang, Y. C., Lo, Y. T., Wahlqvist, M. L., & Lee, M. S. (2015). Breakfast is associated with the metabolic syndrome and school performance among Taiwanese children. *Research in Developmental Disabilities, 43-44* (2015), 179-188. https://doi.org/10.1016/j.ridd.2015.07.003	Study design
Sampasa-Kanyinga, H., Roumeliotis, P., Farrow, C. V., & Shi, Y. F. (2014). Breakfast skipping is associated with cyberbullying and school bullying victimization. A school-based cross-sectional study. *Appetite, 79* (2014), 76-82, https://doi.org/10.1016/j.appet.2014.04.007	Study design
Imberman, S. A., & Kugler, A. D. (2014). The effect of providing breakfast in class on student performance. *Journal of Policy Analysis and Management, 33* (3), 669-699. https://doi.org/10.1002/pam.21759	Study design

Kang, Y. W., & Park, J. H. (2016). Does skipping breakfast and being overweight influence academic achievement among Korean adolescents? *Osong Public Health and Research Perspectives, 7* (4), 220-227. https://doi.org/10.1016/j.phrp.2016.05.004	Study design
Kim, S. Y., Sim, S., Park, B., Kong, I. G., Kim, J. H., & Choi, H. G. (2017). Dietary habits are associated with school performance in adolescents. *Medicine (Baltimore), 95* (12), e3096-e3045. http://doi.org/10.1097/MD.0000000000003096	Study design
Kohyama, J. (2017). Self-reported academic performance and lifestyle habits of school children in Japan. *International Journal of Child Health and Nutrition, 6* (3), 90-97. https://doi.org/10.6000/1929-4247.2017.06.03.1	Study design
Liu, J., Hwang, W. T., Dickerman, B., & Compher, C. (2013). Regular breakfast consumption is associated with increased IQ in kindergarten children. *Early Human Development, 89* (4), 257-262. https://doi.org/10.1016/j.earlhumdev.2013.01.006	Study design
McIsaac, J. L., Kirk, S. F., Kuhle, S. (2015). The association between health behaviours and academic performance in Canadian elementary school students: A cross-sectional study. *International Journal of Environmental Research and Public Health, 12* (11), 14857-14871. https://doi.org/10.3390/ijerph121114857	Study design
Øverby, N., & Høigaard, R. (2012). Diet and behavioral problems at school in Norwegian adolescents. *Food & Nutrition Research, 56* (1), 17231-17237. https://doi.org/10.3402/fnr.v56i0.17231	Study design
Saeidi, Z., Vakili, R., Hashemi, A. G., & Saeidi, M. (2015). The effect of diet on learning of junior high school students in Mashhad, north-east of Iran. *International Journal of Pediatrics, 3* (2.2), 517-526. http://doi.org/10.22038/ijp.2015.4139	Study design
Sampasa-Kanyinga, H., & Hamilton, H. A. (2017). Eating breakfast regularly is related to higher school connectedness and academic performance in Canadian middle- and high-school students. *Public Health, 145* (2017), 120-123. http://doi.org/10.1016/j.puhe.2016.12.027	Study design

Table A2 2. Articles excluded during full-text screening of the initial literature search for Key Question 1b: What is the relationship between eating breakfast and weight-related outcomes?

Article	**Reason for exclusion**
Feeley, A. B., Musenge, E., Pettifor, J. M., & Norris, S. A. (2013). Investigation into longitudinal dietary behaviours and household socio-economic indicators and their association with BMI Z-score and fat mass in South African adolescents: the Birth to Twenty (Bt20) cohort. Public Health Nutrition, 16 (4), 693-703. http://doi.org/10.1017/S1368980012003308	Study setting
Albertson, A. M., Thompson, D., Franko, D. L., Holschuh, N. M., Bauserman, R., & Barton, B. A. (2009). Prospective associations among cereal intake in childhood and adiposity, lipid levels, and physical activity during late adolescence. *Journal of the American Dietetic Association, 109* (10), 1775-1780. https://doi.org/10.1016/j.jada.2009.07.004	Intervention, exposure, or comparator
Ambrosini, G. L., Emmett, P. M., Northstone, K., & Jebb, S. A. (2014). Tracking a dietary pattern associated with increased adiposity in childhood and adolescence. *Obesity (Silver Spring), 22* (2), 458-465. http://doi.org/10.1002/oby.20542	Intervention, exposure, or comparator
Ask, A. S., Hernes, S., Aarek, I., & Vik, F. (2010). Serving of free school lunch to secondary-school pupils - a pilot study with health implications. *Public Health Nutrition, 13* (2), 238-244. https://doi.org/10.1017/S1368980009990772	Intervention, exposure, or comparator

Barbosa, M. I. D., de Oliveira, B. R., de Carvalho, N. A. et al. (2016). Food and Nutrition Education: Influence on students feeding behavior and nutritional status. *Mundo Da Saude, 40*, 399-409. PMID: 26400123	Intervention, exposure, or comparator
Bruening, M., Larson, N., Story, M., Neumark-Sztainer, D., & Hannan, P. (2011). Predictors of adolescent breakfast consumption: longitudinal findings from Project EAT. *Journal of Nutrition Education Behavior, 43* (5), 390-395. https://doi.org/10.1016/j.jneb.2011.02.016	Intervention, exposure, or comparator
Campos Pastor, M. M., Serrano Pardo, M. D., Fernández Soto, M. L. Luna Del Castillo, J. D., & Escobar-Jiménez, F. (2012). Impact of a 'school-based' nutrition intervention on anthropometric parameters and the metabolic syndrome in Spanish adolescents. *Annals of Nutrition & Metabolism, 61* (4), 281-288. http://doi.org/10.1159/000341495	Intervention, exposure, or comparator
Capogrossi, K., & You, W. (2017). The influence of school nutrition programs on the weight of low-income children: A treatment effect analysis. *Health Economics, 26* (8), 980-1000. https://doi.org/10.1002/hec.3378	Intervention, exposure, or comparator
Chen, C. Y., & Hsiao, Y. C. (2018). Dual trajectories of breakfast eating and fruit and vegetable intake over a 5-year follow-up period among economically disadvantaged children: Gender differences. *Appetite, 121* (2018), 41-49. https://doi.org/10.1016/j.appet.2017.10.027	Intervention, exposure, or comparator
Corcoran, S. P., Elbel, B., & Schwartz, A. E. (2016). The effect of breakfast in the classroom on obesity and academic performance: Evidence from New York City. *Journal of Policy Analysis and Management, 35* (3), 509-32. https://doi.org/10.1002/pam.21909	Intervention, exposure, or comparator
Drenowatz, C., Kobel, S., Kettner, S. Kesztyüs, D., Wirt, T., Dreyhaupt, J., & Steinacker, J. M. (2013). Correlates of weight gain in German children attending elementary school. *Preventative Medicine, 57* (4), 310-314. https://doi.org/10.1016/j.ypmed.2013.06.004	Intervention, exposure, or comparator
Elinder, L. S., Heinemans, N., Zeebari, Z., & Patterson, E. (2014). Longitudinal changes in health behaviours and body weight among Swedish school children - Associations with age, gender and parental education - The SCIP school cohort. *BMC Public Health, 14*, 640-649. https://doi.org/10.1186/1471-2458-14-640	Intervention, exposure, or comparator
Fairclough, S. J., Hackett, A. F., Davies, I. G. , Gobbi, R., Mackintosh, K. A., Warburton, G. L., Stratton, G., van Sluijs, E. M., & Boddy, L. M. (2013). Promoting healthy weight in primary school children through physical activity and nutrition education: A pragmatic evaluation of the CHANGE! randomised intervention study. *BMC Public Health, 13*, 626-640. https://doi.org/10.1186/1471-2458-13-626	Intervention, exposure, or comparator
François, P., Guyomard, A., Baudet, D, Dubois-Fabing, D., Boussuges, S., Perrin, F., & Seigneurin, A. (2014). Evaluation of an obesity prevention program for school-aged children in deprived urban areas. *Archives De Pédiatrie, 21* (7), 727-735. http://doi.org/10.1016/j.arcped.2014.04.026	Intervention, exposure, or comparator
Franko, D. L., Albertson, A. M., Thompson, D. R., Barton, B. A. (2011). Cereal consumption and indicators of cardiovascular risk in adolescent girls. *Public Health Nutrition, 14* (4), 584-590. https://doi.org/10.1017/S1368980010002016	Intervention, exposure, or comparator
Heo, M., Jimenez, C. C., Lim, J. , Isasi, C. R., Blank, A. E., Lounsbury, D. W., Fredericks, L., Bouchard, M., Faith, M. S., & Wylie-Rosett, J. (2018). Effective nationwide school-based participatory extramural program on adolescent body mass index, health knowledge and behaviors. *BMC Pediatrics, 18* (1), 7-17. https://doi.org/10.1186/s12887-017-0975-9	Intervention, exposure, or comparator
Hollywood, E., Comiskey, C., Begley, T. Snel, A., O'Sullivan, K., Quirke, M., & Wynne, C. (2013). Measuring and modelling body mass index among a cohort of urban children living with disadvantage. *Journal of Advanced Nursing, 69* (4), 851-861. https://doi.org/10.1111/j.1365-2648.2012.06071.x	Intervention, exposure, or comparator
Jääskeläinen, A., Schwab, U., Kolehmainen, M. Kaakinen, M., Savolainen, M. J., Froguel, P., Cauchi, S., Järvelin, M., & Laitinen, J. (2013). Meal frequencies modify the effect of common genetic variants on body mass index in adolescents of the northern Finland birth cohort 1986. *PLoS One, 8* (9), e73802. https://doi.org/10.1371/journal.pone.0073802	Intervention, exposure, or comparator

Kocken, P. L., Scholten, A., Westhoff, E., De Kok, B. P. H., Taal, E. M., & Goldbohm, R. A. (2016). Effects of a theory-based education program to prevent overweightness in primary school children. Nutrients, 8 (1), 12-29. https://doi.org/10.3390/nu8010012	Intervention, exposure, or comparator
Leidy, H. J., Hoertel, H. A., Douglas, S. M., Higgins, K. A., & Shafer, R. S. (2015). A high-protein breakfast prevents body fat gain, through reductions in daily intake and hunger, in "Breakfast skipping" adolescents. *Obesity (Silver Spring), 23* (9), 1761-1764. https://doi.org/10.1002/oby.21185	Intervention, exposure, or comparator
Mihas, C., Mariolis, A., Manios, Y., Naska, A., Arapaki, A., Mariolis-Sapsakos, T., & Tountas, Y. (2010). Evaluation of a nutrition intervention in adolescents of an urban area in Greece: short- and long-term effects of the VYRONAS study. *Public Health Nutrition, 13* (5), 712-719. https://doi.org/10.1017/S1368980009991625	Intervention, exposure, or comparator
Neumark-Sztainer, D., Wall, M., Haines, J, Story, M., Eisenberg, M. E. (2007). Why does dieting predict weight gain in adolescents? Findings from Project EAT-II: A 5-year longitudinal study. *Journal of the American Dietetic Association, 107* (3), 448-455. https://doi.org/10.1016/j.jada.2006.12.013	Intervention, exposure, or comparator
Ochoa-Avilés, A., Verstraeten, R., Huybregts, L., Andrade, S., Van Camp, J., Donoso, S., Ramírez, P. L., Lachat, C., Maes, L., & Kolsteren, P. (2017). A school-based intervention improved dietary intake outcomes and reduced waist circumference in adolescents: a cluster randomized controlled trial. *Nutrition Journal, 16*, 79. https://doi.org/10.1186/s12937-017-0299-5	Intervention, exposure, or comparator
Pablos, A., Nebot, V., Vañó-Vicent, V., Ceca, D., & Elvira, L. (2018). Effectiveness of a school-based program focusing on diet and health habits taught through physical exercise. *Applied Physiology, Nutrition, and Metabolism, 43* (4), 331-337, https://doi.org/10.1139/apnm-2017-0348	Intervention, exposure, or comparator
Powers, H. J., Stephens, M., Russell, J., & Hill, M. H. (2016). Fortified breakfast cereal consumed daily for 12 wk leads to a significant improvement in micronutrient intake and micronutrient status in adolescent girls: a randomised controlled trial. *Nutrition Journal, 15*, 69. https://doi.org/10.1186/s12937-016-0185-6	Intervention, exposure, or comparator
Raffoul, A., Leatherdale, S. T., & Kirkpatrick, S. I. (2018). Dieting predicts engagement in multiple risky behaviours among adolescent Canadian girls: A longitudinal analysis. *Canadian Journal of Public Health-Revue Canadienne De Sante Publique, 109* (1), 61-69. https://doi.org/10.17269/s41997-018-0025-x	Intervention, exposure, or comparator
Rodearmel, S. J., Wyatt, H. R., Barry, M. J., Dong, F., Pan, D., Israel, R. G., Cho, S. S., McBurney, M. I., & Hill, J. O. (2006). A family-based approach to preventing excessive weight gain. *Obesity (Silver Spring), 14* (8), 1392-1401. https://doi.org/10.1038/oby.2006.158	Intervention, exposure, or comparator
Sacchetti, R., Dallolio, L., Musti, M. A., Guberti, E., Garulli, A., Beltrami, P., Castellazzi, F., Centis, E., Zenesini, C., Coppini, C., Rizzoli, C., Sardocardalano, M., & Leoni, E. (2015). Effects of a school based intervention to promote healthy habits in children 8-11 years old, living in the lowland area of Bologna Local Health Unit. *Annali di Igiene: Medicina Preventiva e di Comunità, 27*, 432-446. http://doi.org/10.7416/ai.2015.2030	Intervention, exposure, or comparator
van Grieken, A., Renders, C. M., Veldhuis, L., Looman, C. W. N., Hirasing, R. A., & Raat, H. (2014). Promotion of a healthy lifestyle among 5-year-old overweight children: Health behavior outcomes of the 'Be active, eat right' study. *BMC Public Health, 14*, 59. https://doi.org/10.1186/1471-2458-14-59	Intervention, exposure, or comparator
van Nassau, F., Singh, A. S., Cerin, E., Salmon, J., van Mechelen, W., Brug, J., & Chinapaw, M. J. M. (2014). The Dutch Obesity Intervention in Teenagers (DOiT) cluster controlled implementation trial: intervention effects and mediators and moderators of adiposity and energy balance-related behaviours. *International Journal of Behavioral Nutrition and Physical Activity, 11*, 158. https://doi.org/10.1186/s12966-014-0158-0	Intervention, exposure, or comparator
Watts, A. W., Mason, S. M., Loth, K., Larson, N., & Newmark-Sztainer, D. (2016). Socioeconomic differences in overweight and weight-related behaviors across adolescence and young adulthood: 10-year longitudinal findings from Project EAT. *Preventative Medicine, 87* (2016), 194-199. https://doi.org/10.1016/j.ypmed.2016.03.007	Intervention, exposure, or comparator

Westerberg-Jacobson, J., Edlund, B., & Ghaderi, A. (2010). A 5-year longitudinal study of the relationship between the wish to be thinner, lifestyle behaviours and disturbed eating in 9-20-year old girls. *European Eating Disorders Review, 18* (3), 207-219. https://doi.org/10.1002/erv.983	Intervention, exposure, or comparator
Wirt, T., Hundsdörfer, V., Schreiber, A., Kesztyüs, D., Steinacker, J. M., & The Komm mit in das gesunde Boot-Grundschule" - Research Group (2014). Associations between inhibitory control and body weight in German primary school children. *Eating Behaviors, 15* (1), 9-12. https://doi.org/10.1016/j.eatbeh.2013.10.015	Intervention, exposure, or comparator
Yamada, M., Sekine, M., & Tatsuse, T. (2018). Parental internet use and lifestyle factors as correlates of prolonged screen time of children in Japan: Results from the Super Shokuiku School Project. *Journal of Epidemiology, 28* (10), 407-413. https://doi.org/10.2188/jea.JE20170100	Intervention, exposure, or comparator
Yamaoka, K., Watanabe, M., Hida, E., & Tango, T. (2011). Impact of group-based dietary education on the dietary habits of female adolescents: A cluster randomized trial. *Public Health Nutrition, 14* (4), 702-708. https://doi.org/10.1017/S1368980010002405	Intervention, exposure, or comparator
Alwattar, A. Y., Thyfault, J. P., & Leidy, H. J. (2015). The effect of breakfast type and frequency of consumption on glycemic response in overweight/obese late adolescent girls. *European Journal of Clinical Nutrition, 69* (2015), 885-890. http://doi.org/10.1038/ejcn.2015.12	Outcome
Bellisle, F., Rolland-Cachera, M. F., & Kellogg Scientific Advisory Committee (2007). Three consecutive (1993, 1995, 1997) surveys of food intake, nutritional attitudes and knowledge, and lifestyle in 1000 French children, aged 9-11 years. *Journal of Human Nutrition and Dietetics, 20* (3), 241-251. http://doi.org/10.1111/j.1365-277X.2007.00789.x	Outcome
Crepinsek, M. K., Singh, A., Bernstein, L. S., & McLaughlin, J. E. (2006). Dietary effects of universal-free school breakfast: findings from the evaluation of the school breakfast program pilot project. *Journal of the American Dietetic Association, 106* (11), 1796-1803. https://doi.org/10.1016/j.jada.2006.08.013	Outcome
Lipsky, L. M., Nansel, T. R., Haynie, D. L., Liu, D., Li, K., Pratt, C. A., Iannotti, R. J., & Dempster, K. W. (2017). Diet quality of US adolescents during the transition to adulthood: Changes and predictors. *American Journal of Clinical Nutrition, 105* (6) 1424-1432. https://doi.org/10.3945/ajcn.116.150029	Outcome
Meijerink, F. J., van Vuuren, C. L., Wijnhoven, H. A, & van Eijsden, M. (2016). Seven-year time trends in energy balance-related behaviours according to educational level and ethnic background among 14-year-old adolescents. *Public Health Nutrition, 19* (5), 777-787. https://doi.org/10.1017/S1368980015001743	Outcome
Pedersen, T. P., Holstein, B. E., Flachs, E. M., & Rasmussen, M. (2013). Meal frequencies in early adolescence predict meal frequencies in late adolescence and early adulthood. *BMC Public Health, 13*, 445. https://doi.org/10.1186/1471-2458-13-445	Outcome
Roßbach, S., Diederichs, T., Bolzenius, K., Herder, C., Buyken, A. E., & Alexy, U. (2017). Age and time trends in eating frequency and duration of nightly fasting of German children and adolescents. *European Journal of Nutrition, 56* (8), 2507-2517. http://doi.org/10.1007/s00394-016-1286-x	Outcome
Roßbach, S., Diederichs, T., Herder, C., Buyken, A. E., & Alexy, U. (2018). Time and age trends in morning and evening protein intakes of German children and adolescents. *Journal of Nutritional Science, 7* (e9), 1-8. https://doi.org/10.1017/jns.2018.1	Outcome
Sevindi, T. (2012). The effects of nutrition habits of secondary school students on their educational status. *Energy Education Science and Technology Part B-Social and Educational Studies, 4*, 2119-2128.	Outcome
Zaqout, M., Vyncke, K., Moreno, L. A., De Miguel-Etayo, P., Lauria, F., Molnar, D., Lissner, L., Hunsberger, M., Veidebaum, T., Tornaritis, M., Reisch, L. A., Bammann, K., Sprengeler, O., Ahrens, W., & Michels, N. (2016). Determinant factors of physical fitness in European children. *International Journal of Public Health, 61* (5), 573-582. http://doi.org/10.1007/s00038-016-0811-2	Outcome

Hollar, D., Heitz, C., & Zhou, W. (2015). Abstract MP30: More young children in an obesity prevention intervention in MS and LA Head Start centers improve/maintain BMI percentile and waist circumference compared to nonparticipants. *Circulation, 131* (Supplement 1).	Study design
Küpers, L. K., de Pijper, J. J., Sauer, P. J., Stolk, R. P., & Corpeleijn, E. (2014). Skipping breakfast and overweight in 2- and 5-year-old Dutch children-the GECKO Drenthe cohort. *International Journal of Obesity (London), 38*, 569-571. http://doi.org/10.1038/ijo.2013.194	Study design
Pbert, L., Druker, S., Barton, B., Schneider, K. L., Olendzki, B., Gapinski, M. A., Kurtz, S., & Stavroula, O. (2016). A school-based program for overweight and obese adolescents: A randomized controlled trial. *Journal of School Health, 86* (10), 699-708. https://doi.org/10.1111/josh.12428	Study design
Péneau, S., Thibault, H., Meless, D., Soulié, D., Carbonel, P., Roinsol, D., Longueville, E., Sérog, P., Deheeger, M., Bellisle, F., Maurice-Tison, S., & Rolland-Cachera, M. F. (2008). Anthropometric and behavioral patterns associated with weight maintenance after an obesity treatment in adolescents. Journal of Pediatrics, 152 (5), 678-684. https://doi.org/10.1016/j.jpeds.2007.09.053	Study design
Serrano, M, Campos, M, Escobar, Gome-Villalba F et al. (2016). Variations in the states of prediabetes in adolescents after a school programme for nutritional and behavioural intervention. Diabetologia,59.(supplement 1)S331-S332. https://doi.org/10.1007/s00125-016-4046-9	Study design
Albertson, A. M., Affenito, S. G., Bauserman, R., Holschuh, N. M., Eldridge, A. L., & Barton, B. A. (2009). The relationship of ready-to-eat cereal consumption to nutrient intake, blood lipids, and body mass index of children as they age through adolescence. *Journal of the American Dietetic Association, 109* (9), 1557-1565. https://doi.org/10.1016/j.jada.2009.06.363	Study design
Alsharairi, N. A., & Somerset, S. M. (2016). Skipping breakfast in early childhood and its associations with maternal and child BMI: A study of 2-5-year-old Australian children. *European Journal of Clinical Nutrition, 70*, 450-455. http://doi.org/10.1038/ejcn.2015.184	Study design
Ask, A. S., Hernes, S., Aarek, I., Johannessen, G., & Haugen, M. (2006). Changes in dietary pattern in 15 year old adolescents following a 4 month dietary intervention with school breakfast - a pilot study. *Nutrition Journal, 5*, 33. https://doi.org/10.1186/1475-2891-5-33	Study design
Baxter, S. D., Paxton-Aiken, A. E., Tebbs, J. M., Royer, J. A., Guinn, C. H., & Finney, C. J. (2012). Secondary analyses of data from 4 studies with fourth-grade children show that sex, race, amounts eaten of standardized portions, and energy content given in trades explain the positive relationship between body mass index and energy intake at school-provided meals. *Nutrition Research, 32* (9), 659-668. https://doi.org/10.1016/j.nutres.2012.07.001	Study design
Isoldi, K. K., Calderon, O., & Dolar, V. (2014). Cooking up energy: Response to a youth-focused afterschool cooking and nutrition education program. *Topics in Clinical Nutrition, 29* (2), 123-131. https://doi.org/10.1097/01.TIN.0000445896.52276.0e	Study design
Jääskeläinen, A., Schwab, U., Kolehmainen, M., Pirkola, J., Järvelin, M.-R., & Laitinen, J. (2013). Associations of meal frequency and breakfast with obesity and metabolic syndrome traits in adolescents of Northern Finland Birth Cohort 1986. *Nutrition, Metabolism and Cardiovascular Diseases, 23*, (10), 1002-1009. https://doi.org/10.1016/j.numecd.2012.07.006	Study design
Kapantais, E., Chala, E., Kaklamanou, D., Lanaras L., Kaklamanou, M., & Tzotzas, T. (2010). Breakfast skipping and its relation to BMI and health-compromising behaviours among Greek adolescents. *Public Health Nutrition, 14* (1), 101-108. https://doi.org/10.1017/S1368980010000765	Study design
O'Dea, J. A., & Wagstaff, S. (2011). Increased breakfast frequency and nutritional quality among schoolchildren after a national breakfast promotion campaign in Australia between 2000 and 2006. *Health Education Research, 26* (6), 1086-1096. https://doi.org/10.1093/her/cyr042	Study design
Park, E. H., Oh, M. S., Kim, S., Lee, J., & Kang, K. S. (2018). The analysis of factors causing the high prevalence of child obesity in Jeju Island. *Pediatric Gastroenterology, Hepatology & Nutrition, 21* (2), 127-133. https://doi.org/10.5223/pghn.2018.21.2.127	Study design

Reeves, S., Huber, J. W., Halsey, L. G., Horabady-Farahani, Y., Ijadi, M., & Smith, T. (2014). Experimental manipulation of breakfast in normal and overweight/obese participants is associated with changes to nutrient and energy intake consumption patterns. *Physiology & Behavior, 133*, 130-135. https://doi.org/10.1016/j.physbeh.2014.05.015	Study design
Trancoso, S. C., Cavalli, S. B., & Proença, R. P. D. (2010). Breakfast: characterization, consumption and importance for health. *Revista De Nutricao-Brazilian Journal of Nutrition, 23* (5), 859-869. http://doi.org/10.1590/S1415-52732010000500016	Study design
Vericker, T. C. (2014). Children's school-related food and physical activity behaviors are associated with body mass index. *Journal of the Academy of Nutrition and Dietetics, 114* (2), 250-256. https://doi.org/10.1016/j.jand.2013.07.046	Study design
Zurriaga, O., Perez-Panades, J., Izquierdo, J. Q., Costa, M. G., Anes, Y., Quiñones, C., Margolles, M., Lopez-Maside, A., Vega-Alonso, A. T., Espí, M. T. M., & Recent OBICE Research Group. (2011). Factors associated with childhood obesity in Spain. The OBICE study: A case-control study based on sentinel networks. *Public Health Nutrition, 14* (6), 1105-1113. https://doi.org/10.1017/S1368980010003770	Study design

Table A2 3. Articles excluded during full-text screening of the initial literature search for Key Question 1c: What is the relationship between eating breakfast and health?

Article	Reason for exclusion
Albertson, A. M., Affenito, S. G., Bauserman, R., Holschuh, N. M., Eldridge, A. L., & Barton, B. A. (2009). The relationship of ready-to-eat cereal consumption to nutrient intake, blood lipids, and body mass index of children as they age through adolescence. *Journal of the American Dietetic Association, 109*(9), 1557-1565. http://doi.org/10.1016/j.jada.2009.06.363	Intervention, exposure, or comparator
Bonnet, F., Lepicard, E. M., Cathrin, L., Letellier, C., Constant, F., Hawili, N., & Friedlander, G. (2012). French children start their school day with a hydration deficit. *Annals of Nutrition & Metabolism, 60*(4), 257-263. http://doi.org/10.1159/000337939	Intervention, exposure, or comparator
Miller, D. P., Waldfogel, J., & Han, W. J. (2012). Family meals and child academic and behavioral outcomes. *Child Development, 83*(6), 2104-2120. http://doi.org/10.1111/j.1467-8624.2012.01825.x	Intervention, exposure, or comparator
Simetin, I. P., Kuzman, M., Franelic, I. P., Pristas, I., Benjak, T., & Dezeljin, J. D. (2011). Inequalities in Croatian pupils' unhealthy behaviours and health outcomes: role of school, peers and family affluence. *European Journal of Public Health, 21*(1), 122-128. http://doi.org/10.1093/eurpub/ckq002	Intervention, exposure, or comparator
Stookey, J. D., Brass, B., Holliday, A., & Arieff, A. (2012). What is the cell hydration status of healthy children in the USA? Preliminary data on urine osmolality and water intake. *Public Health Nutrition, 15*(11), 2148-2156. http://doi.org/10.1017/s1368980011003648	Intervention, exposure, or comparator
Cordero, M. J. A., Jimenez, E. G., Perona, J. S., Lopez, C. A. P., Ferre, J. A., Villar, N. M., & Garcia, F. R. (2010). The Guadix Study of the effects of a Mediterranean-diet breakfast on the postprandial lipid parameters of overweight and obese pre-adolescents. *Nutricion Hospitalaria, 25*(6), 1025-1033. PMID: 21519776	Publication language
Park, E. (2008). The influencing factors on suicide attempt among adolescents in South Korea. *Journal of Korean Academy of Nursing, 38*(3), 465-473. http://doi.org/10.4040/jkan.2008.38.3.465	Publication language
Perez-Lancho, C., Ruiz-Prieto, I., Bolanos-Rios, P., & Jauregui-Lobera, I. (2013). Salivary cortisol as a measure of stress during a nutrition education program in adolescents. *Nutricion Hospitalaria, 28*(1), 211-216. http://doi.org/10.3305/nh.2013.28.1.6261	Publication language

Quintero-Gutierrez, A. G., Gonzalez-Rosendo, G., Rodriguez-Murguia, N. A., Reyes-Navarrete, G. E., Puga-Diaz, R., & Villanueva-Sanchez, J. (2014). Skipping breakfast, nutritional state, and food habits of children and adolescents in public schools of Morelos, Mexico. *CyTa-Journal of Food, 12*(3), 256-262. http://doi.org/10.1080/19476337.2013.839006	Publication language
Traub, M., Steinacker, J. M., Kesztyus, D., & Arbeitsgrp Komm Gesunde, Boot (2017). Avoiding breakfast for the primary school children cofactors as an important basis for targeted prevention measures. *Ernahrungs Umschau, 64*(9), M494. http://doi.org/10.4455/eu.2017.035	Publication language
Eleftheriadou, M., Stefanidis, K., Lykeridou, K., Iliadis, I., & Michala, L. (2015). Dietary habits in adolescent girls with polycystic ovarian syndrome. *Gynecological Endocrinology, 31*(4), 269-271. http://doi.org/10.3109/09513590.2014.984677	Outcome
Holmberg, L. I.,& Hellberg, D. (2008). Behavioral and other characteristics of relevance for health in adolescents with self-perceived sleeping problems. *International Journal of Adolescent Medicine and Health, 20*(3), 353-365. https://doi.org/10.1515/IJAMH.2008.20.3.353	Outcome
Iovino, I., Stuff, J., Liu, Y., Brewton, C., Dovi, A., Kleinman, R., & Nicklas, T. (2016). Breakfast consumption has no effect on neuropsychological functioning in children: a repeated-measures clinical trial. *American Journal of Clinical Nutrition, 104*(3), 715-721. http://doi.org/10.3945/ajcn.116.132043	Outcome
Kelly, Y., Patalay, P., Montgomery, S., & Sacker, A. (2016). BMI development and early adolescent psychosocial well-being: UK Millennium Cohort Study. *Pediatrics, 138*(6), e20160967. http://doi.org/10.1542/peds.2016-0967	Outcome
Olafsdottir, A. S., Torfadottir, J. E., & Arngrimsson, S. A. (2016). Health behavior and metabolic risk factors associated with normal weight obesity in adolescents. *PLoS One, 11*(8), e0161451. http://doi.org/10.1371/journal.pone.0161451	Outcome
Overby, N. C., Margeirsdottir, H. D., Brunborg, C., Dahl-Jorgensen, K., & Andersen, L. F. (2008). Sweets, snacking habits, and skipping meals in children and adolescents on intensive insulin treatment. *Pediatric Diabetes, 9*(4 Pt 2), 393-400. http://doi.org/10.1111/j.1399-5448.2008.00381.x	Outcome
Vierola, A., Suominen, A. L., Eloranta, A. M., Lintu, N., Ikavalko, T., Narhi, M., & Lakka, T. A. (2017). Determinants for craniofacial pains in children 6-8 years of age: The PANIC study. *Acta Odontologica Scandinavica, 75*(6), 453-460. http://doi.org/10.1080/00016357.2017.1339908	Outcome
Vondrova, D., Kapsdorfer, D., Argalasova, L., Hirosova, K., Samohyl, M., & Sevcikova, L. (2017). The impact of selected environmental, behavioral and psychosocial factors on schoolchildren's somatic and mental health. *Reviews on Environmental Health, 32*(1-2), 189-192. http://doi.org/10.1515/reveh-2016-0034	Outcome
Benton, D., & Brock, H. (2010). Mood and the macro-nutrient composition of breakfast and the mid-day meal. *Appetite, 55*(3), 436-440. http://doi.org/10.1016/j.appet.2010.08.001	Participant characteristics
Bougard, C., Moussay, S., Gauthier, A., Espie, S., & Davenne, D. (2009). Effects of waking time and breakfast intake prior to evaluation of psychomotor performance in the early morning. *Chronobiology International, 26*(2), 324-336. http://doi.org/10.1080/07420520902774540	Participant characteristics
Brown, D., & Wyon, M. (2014). The effect of moderate glycemic energy bar consumption on blood glucose and mood in dancers. *Medical Problems of Performing Artists, 29*(1), 27-31. https://doi.org/10.21091/mppa.2014.1007	Participant characteristics
Fernandez-Aranda, F., Krug, I., Granero, R., Ramon, J. M., Badia, A., Gimenez, L., Solano, R., Collier, D., Karwautz, A., & Treasure, J. (2007). Individual and family eating patterns during childhood and early adolescence: An analysis of associated eating disorder factors. *Appetite, 49*(2), 476-485. http://doi.org/10.1016/j.appet.2007.03.004	Participant characteristics

Geliebter, A., Grillot, C. L., Aviram-Friedman, R., Haq, S., Yahav, E., & Hashim, S. A. (2015). Effects of oatmeal and corn flakes cereal breakfasts on satiety, gastric emptying, glucose, and appetite-related hormones. *Annals of Nutrition & Metabolism, 66*(2-3), 93-103. http://doi.org/10.1159/000365933	Participant characteristics
Ishimoto, Y., Yoshida, M., Nagata, K., Yamada, H., Hashizume, H., & Yoshimura, N. (2013). Consuming breakfast and exercising longer during high school increases bone mineral density in young adult men. *Journal of Bone and Mineral Metabolism, 31*(3), 329-336. http://doi.org/10.1007/s00774-012-0415-8	Participant characteristics
Jin, Y., He, L., Kang, Y., Chen, Y., Lu, W., Ren, X., Song, X., Wang, L., Nie, Z., Guo, D., & Yao, Y. (2014). Prevalence and risk factors of anxiety status among students aged 13-26 years. *International Journal of Clinical and Experimental Medicine, 7*(11), 4420-4426. PMID: 25550963	Participant characteristics
Odegaard, A. O., Jacobs, D. R., Jr., Steffen, L. M., Van Horn, L., Ludwig, D. S., & Pereira, M. A. (2013). Breakfast frequency and development of metabolic risk. *Diabetes Care, 36*(10), 3100-3106. http://doi.org/10.2337/dc13-0316	Participant characteristics
Smith, Andrew P. (2011). Breakfast cereal, digestive problems and well-being. *Stress & Health, 27*(5), 388-394. http://doi.org/10.1002/smi.1390	Participant characteristics
Brindal, E., Hendrie, G., Noakes, M., Celander, M., & Brinkworth, G. (2011). A randomised controlled trial to compare the effect of breakfast cereals differing in fibre content on short-term appetite and mood in 8-12 year old children. *Australasian Medical Journal, 4*(12), 706.	Publication status
Ruxton, C. (2011). Breakfast clubs: The nutritional, social and health benefits. *Nursing in Practice: The Journal for Today's Primary Care Nurse*(60), 5p-5p.	Publication status
Afifi, M. (2006). Positive health practices and depressive symptoms among high school adolescents in Oman. Singapore Medical Journal, 47(11), 960-966. PMID: 17075664	Study design
Agostini, A., Hawkes, A., Lewkowicz, A., Lushington, K., & Dorrian, J. (2017). Are sleep, bullying, and breakfast and junk food consumption related to anxiety, sadness and health in late childhood and adolescence? *Sleep Medicine, 40* (Supplement 1), e6. https://doi.org/10.1016/j.sleep.2017.11.010	Study design
Ahadi, Z., Kelishadi, R., Qorbani, M., Zahedi, H., Aram, M., Motlagh, M. E., Ardalan, G., Shafiee, G., Arzaghi, S. M., Asayesh, H., & Heshmat, R. (2016). Association of breakfast intake with psychiatric distress and violent behaviors in Iranian children and adolescents: The CASPIAN- IV study. *Indian Journal of Pediatrics, 83*(9), 922-929. http://doi.org/10.1007/s12098-016-2049-7	Study design
Ahadi, Z., Qorbani, M., Kelishadi, R., Ardalan, G., Motlagh, M. E., Asayesh, H., Zeynali, M., Chinian, M., Larijani, B., Shafiee, G., & Heshmat, R. (2015). Association between breakfast intake with anthropometric measurements, blood pressure and food consumption behaviors among Iranian children and adolescents: The CASPIAN-IV study. *Public Health, 129*(6), 740-747. http://doi.org/10.1016/j.puhe.2015.03.019	Study design
ALBashtawy, M. (2015). Exploring the reasons why school students eat or skip breakfast. *Nursing Children & Young People, 27*(6), 16-22. http://doi.org/10.7748/ncyp.27.6.16.e622	Study design
Alexander, K. E., Ventura, E. E., Spruijt-Metz, D., Weigensberg, M. J., Goran, M. I., & Davis, J. N. (2009). Association of breakfast skipping with visceral fat and insulin indices in overweight Latino youth. *Obesity (Silver Spring), 17*(8), 1528-1533. http://doi.org/10.1038/oby.2009.127	Study design
Ansari, H., Kelishadi, R., Qorbani, M., Mansourian, M., Ahadi, Z., Motlagh, M. E., Ardalan, G., Safiri, S., Asayesh, H., Mohammadi, R., & Heshmat, R. (2016). Is meal frequency associated with mental distress and violent behaviors in children and adolescents? The CASPIAN IV study. *International Journal of Pediatrics-Mashhad, 4*(7), 2247-2255. https://doi.org/10.22038/ijp.2016.7177	Study design
Arat, G. (2015). Emerging protective and risk factors of mental health in Asian American students: findings from the 2013 Youth Risk Behavior Survey. *Vulnerable Children and Youth Studies, 10*(3), 192-205. http://doi.org/10.1080/17450128.2015.1045437	Study design

Arbour-Nicitopoulos, K. P., Faulkner, G. E., & Irving, H. M. (2012). Multiple health-risk behaviour and psychological distress in adolescence. *Journal of the American Academy of Child and Adolescent Psychiatry, 21*(3), 171-178. PMID: 22876262	Study design
Barba, G., Troiano, E., Russo, P., Siani, A., & ARCA Project Study Group (2006). Total fat, fat distribution and blood pressure according to eating frequency in children living in southern Italy: The ARCA Project. *International Journal of Obesity, 30*(7), 1166-1169. http://doi.org/10.1038/sj.ijo.0803257	Study design
Bel-Serrat, S., Mouratidou, T., Bornhorst, C., Peplies, J., De Henauw, S., Marild, S., Molnar, D., Siani, A., Tornaritis, M., Veidebaum, T., Krogh, V., & Moreno, L. A. (2013). Food consumption and cardiovascular risk factors in European children: The IDEFICS Study. *Pediatric Obesity, 8*(3), 225-236. http://doi.org/10.1111/j.2047-6310.2012.00107.x	Study design
Blank, M., Zhang, J., Lamers, F., Taylor, A. D., Hickie, I. B., & Merikangas, K. R. (2015). Health correlates of insomnia symptoms and comorbid mental disorders in a nationally representative sample of US adolescents. *Sleep, 38*(2), 197-204. http://doi.org/10.5665/sleep.4396	Study design
Bolton, K. A., Jacka, F., Allender, S., Kremer, P., Gibbs, L., Waters, E., & de Silva, A. (2016). The association between self-reported diet quality and health-related quality of life in rural and urban Australian adolescents. *Australian Journal of Rural Health, 24*(5), 317-325. http://doi.org/10.1111/ajr.12275	Study design
Campos Pastor, M. M., Serrano Pardo, M. D., Fernandez Soto, M. L., Luna Del Castillo, J. D., & Escobar-Jimenez, F. (2012). Impact of a 'school-based' nutrition intervention on anthropometric parameters and the metabolic syndrome in Spanish adolescents. *Annals of Nutrition & Metabolism, 61*(4), 281-288. http://doi.org/10.1159/000341495	Study design
Cayres, S. U., Junior, I. F., Barbosa, M. F., Christofaro, D. G., & Fernandes, R. A. (2016). Breakfast frequency, adiposity, and cardiovascular risk factors as markers in adolescents. *Cardiology in the Young, 26*(2), 244-249. http://doi.org/10.1017/s1047951115000050	Study design
Chen, X., Sekine, M., Hamanishi, S., Wang, H., Gaina, A., Yamagami, T., & Kagamimori, S. (2005). Lifestyles and health-related quality of life in Japanese school children: a cross-sectional study. *Preventative Medicine, 40*(6), 668-678. http://doi.org/10.1016/j.ypmed.2004.09.034	Study design
Cuenca-Garcia, M., Ruiz, J. R., Ortega, F. B., Labayen, I., Gonzalez-Gross, M., Moreno, L. A., Gomez-Martinez, S., Ciarapica, D., Hallstrom, L., Wastlund, A., Molnar, D., Gottrand, F., Manios, Y., Widhalm, K., Kafatos, A., De Henauw, S., Sjostrom, M., & Castillo, M. J. (2014). Association of breakfast consumption with objectively measured and self-reported physical activity, sedentary time and physical fitness in European adolescents: The HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) study. *Public Health Nutrition, 17*(10), 2226-2236. http://doi.org/10.1017/s1368980013002437	Study design
Donin, A. S., Nightingale, C. M., Owen, C. G., Rudnicka, A. R., Perkin, M. R., Jebb, S. A., Stephen, A. M., Sattar, N., Cook, D. G., & Whincup, P. H. (2014). Regular breakfast consumption and type 2 diabetes risk markers in 9- to 10-year-old children in the child heart and health study in England (CHASE): A cross-sectional analysis. *PLoS Med, 11*(9), e1001703. http://doi.org/10.1371/journal.pmed.1001703	Study design
Farajian, P., Panagiotakos, D. B., Risvas, G., Micha, R., Tsioufis, C., & Zampelas, A. (2015). Dietary and lifestyle patterns in relation to high blood pressure in children: The GRECO study. *Journal of Hypertension, 33*(6), 1174-1181. http://doi.org/10.1097/hjh.0000000000000536	Study design
Freitas Junior, I. F., Christofaro, D. G., Codogno, J. S., Monteiro, P. A., Silveira, L. S., & Fernandes, R. A. (2012). The association between skipping breakfast and biochemical variables in sedentary obese children and adolescents. *Journal of Pediatrics, 161*(5), 871-874. http://doi.org/10.1016/j.jpeds.2012.04.055	Study design
Gates, G., & Perera, T. (2013). Association between breakfast consumption and nutritional status in 9 to 13 year old children. *Journal of Nutrition Education & Behavior, 45*(4S), S31-S31. https://doi.org/10.1016/j.jneb.2013.04.084	Study design
Gilardini, L., Croci, M., Pasqualinotto, L., Caffetto, K., & Invitti, C. (2015). Dietary habits and cardiometabolic health in obese children. *Obesity Facts, 8*(2), 101-109. http://doi.org/10.1159/000381157	Study design

Guo, X., Zhang, X., Li, Y., Zhou, X., Yang, H., Ma, H., Wang, N., Liu, J., Zheng, L., & Sun, Y. (2012). Differences in healthy lifestyles between prehypertensive and normotensive children and adolescents in Northern China. *Pediatric Cardiology, 33*(2), 222-228. http://doi.org/10.1007/s00246-011-0112-8	Study design
Hallstrom, L., Labayen, I., Ruiz, J. R., Patterson, E., Vereecken, C. A., Breidenassel, C., Gottrand, F., Huybrechts, I., Manios, Y., Mistura, L., Widhalm, K., Kondaki, K., Moreno, L. A., Sjostrom, M. (2013). Breakfast consumption and CVD risk factors in European adolescents: The HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) study. *Public Health Nutrition, 16*(7), 1296-1305. https://doi.org/10.1017/S1368980012000973	Study design
Hirschler, V., Maccallini, G., Aranda, C., & Molinari, C. (2012). Lifestyle behaviors and dyslipidemia in Argentinean native versus urban children. *Clinical Biochemistry, 45*(15), 1161-1166. http://doi.org/10.1016/j.clinbiochem.2012.04.020	Study design
Ho, C. Y., Huang, Y. C., Lo, Y. T., Wahlqvist, M. L., & Lee, M. S. (2015). Breakfast is associated with the metabolic syndrome and school performance among Taiwanese children. *Research in Developmental Disabilities, 43-44*, 179-188. http://doi.org/10.1016/j.ridd.2015.07.003	Study design
Hong, S. A., & Peltzer, K. (2017). Dietary behaviour, psychological well-being and mental distress among adolescents in Korea. *Child and Adolescent Psychiatry and Mental Health, 11*, 56. http://doi.org/10.1186/s13034-017-0194-z	Study design
Huang, C. J., Hu, H. T., Fan, Y. C., Liao, Y. M., & Tsai, P. S. (2010). Associations of breakfast skipping with obesity and health-related quality of life: evidence from a national survey in Taiwan. *International Journal of Obesity (London), 34*(4), 720-725. http://doi.org/10.1038/ijo.2009.285	Study design
Itani, O., Kaneita, Y., Munezawa, T., Ikeda, M., Osaki, Y., Higuchi, S., Kanda, H., Nakagome, S., Suzuki, K., & Ohida, T. (2016). Anger and impulsivity among Japanese adolescents: A nationwide representative survey. *Journal of Clinical Psychiatry, 77*(7), e860-e866. http://doi.org/10.4088/JCP.15m10044	Study design
Jaaskelainen, A., Schwab, U., Kolehmainen, M., Pirkola, J., Jarvelin, M. R., & Laitinen, J. (2013). Associations of meal frequency and breakfast with obesity and metabolic syndrome traits in adolescents of Northern Finland Birth Cohort 1986. *Nutrition, Metabolism and Cardiovascular Diseases, 23*(10), 1002-1009. http://doi.org/10.1016/j.numecd.2012.07.006	Study design
Kennedy, S., Ryan, L., & Clegg, M. E. (2016). The effect of a breakfast containing multiple functional ingredients on glucose response, insulin response and cognitive performance in adolescents. *Proceedings of the Nutrition Society, 75*(OCE3), 1. http://doi.org/10.1017/S0029665116002196	Study design
Kim, S. H., Song, Y. H., Park, S., & Park, M. J. (2016). Impact of lifestyle factors on trends in lipid profiles among Korean adolescents: The Korea National Health and Nutrition Examination Surveys study, 1998 and 2010. *Korean Journal of Pediatrics, 59*(2), 65-73. http://doi.org/10.3345/kjp.2016.59.2.65	Study design
Kollias, A., Antonodimitrakis, P., Grammatikos, E., Chatziantonakis, N., Grammatikos, E. E., & Stergiou, G. S. (2009). Trends in high blood pressure prevalence in Greek adolescents. *Journal of Human Hypertension, 23*(6), 385-390. http://doi.org/10.1038/jhh.2008.166	Study design
Kye, S. Y., Kwon, J. H., & Park, K. (2016). Happiness and health behaviors in South Korean adolescents: A cross-sectional study. *Epidemiology & Health, 38*, e2016022. http://doi.org/10.4178/epih.e2016022	Study design
Lazzeri, G., Azzolini, E., Pammolli, A., Simi, R., Meoni, V., & Giacchi, M. V. (2014). Factors associated with unhealthy behaviours and health outcomes: A cross-sectional study among Tuscan adolescents (Italy). *International Journal for Equity in Health, 13*(1), 83. http://doi.org/10.1186/s12939-014-0083-5	Study design
Lee, G., Han, K., & Kim, H. (2017). Risk of mental health problems in adolescents skipping meals: The Korean National Health and Nutrition Examination Survey 2010 to 2012. *Nursing Outlook, 65*(4), 411-419. http://doi.org/10.1016/j.outlook.2017.01.007	Study design
Lepkowska, D. (2015). The importance of a healthy breakfast to start the school day. *British Journal of School Nursing, 10*(4), 171-174. https://doi.org/10.12968/bjsn.2015.10.4.171	Study design

Li, W., Sekine, M., Yamada, M., Fujimura, Y., & Tatsuse, T. (2018). Lifestyle and overall health in high school children: Results from the Toyama birth cohort study, Japan *Pediatrics International, 60*(5), 467-473. http://doi.org/10.1111/ped.13548	Study design
Lien, L. (2007). Is breakfast consumption related to mental distress and academic performance in adolescents? *Public Health Nutrition, 10*(4), 422-428. http://doi.org/10.1017/s1368980007258550	Study design
Marlatt, K. L., Farbakhsh, K., Dengel, D. R., & Lytle, L. A. (2016). Breakfast and fast food consumption are associated with selected biomarkers in adolescents. *Preventive Medicine Reports, 3*, 49-52. http://doi.org/10.1016/j.pmedr.2015.11.014	Study design
Mielgo-Ayuso, J., Valtuena, J., Cuenca-Garcia, M., Gottrand, F., Breidenassel, C., Ferrari, M., Manios, Y., De Henauw, S., Widhalm, K., Kafatos, A., Kersting, M., Huybrechts, I., Moreno, L. A., & Gonzalez-Gross, M. (2017). Regular breakfast consumption is associated with higher blood vitamin status in adolescents: The HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) study. *Public Health Nutrition, 20*(8), 1393-1404. http://doi.org/10.1017/s1368980016003645	Study design
Monzani, A., Rapa, A., Fuiano, N., Diddi, G., Prodam, F., Bellone, S., & Bona, G. (2014). Metabolic syndrome is strictly associated with parental obesity beginning from childhood. *Clinical Endocrinology (Oxford), 81*(1), 45-51. http://doi.org/10.1111/cen.12261	Study design
Moreno, C., Garcia-Moya, I., Rivera, F., & Ramos, P. (2016). Characterization of vulnerable and resilient Spanish adolescents in their developmental contexts. *Frontiers in Psychology, 7*, 983. http://doi.org/10.3389/fpsyg.2016.00983	Study design
Morioka, H., Itani, O., Kaneita, Y., Iwasa, H., Ikeda, M., Yamamoto, R., Osaki, Y., Kanda, H., Nakagome, S., & Ohida, T. (2014). Factors affecting unhappiness at school among Japanese adolescents: An epidemiological study. *PLoS One, 9*(11), e111844. http://doi.org/10.1371/journal.pone.0111844	Study design
Moschiano, F., Messina, P., D'Amico, D., Grazzi, L., Frediani, F., Casucci, G., d'Onofrio, F., Demurtas, A., Beghi, E., & Bussone, G. (2012). Headache, eating and sleeping behaviors and lifestyle factors in preadolescents and adolescents: Preliminary results from an Italian population study. *Neurological Sciences, 33* (Supplement 1), S87-S90. http://doi.org/10.1007/s10072-012-1048-3	Study design
Oak, J. W., & Lee, H. S. (2012). Prevalence rate and factors associated with atopic dermatitis among Korean middle school students. *Journal of Korean Academy of Nursing, 42*(7), 992-1000. http://doi.org/10.4040/jkan.2012.42.7.992	Study design
Olson, M. L., Maalouf, N. M., Oden, J. D., White, P. C., & Hutchison, M. R. (2012). Vitamin D deficiency in obese children and its relationship to glucose homeostasis. *Journal of Clinical Endocrinology & Metabolism, 97*(1), 279-285. http://doi.org/10.1210/jc.2011-1507	Study design
Osawa, H., Sugihara, N., Ukiya, T., Ishizuka, Y., Birkhed, D., Hasegawa, M., & Matsukubo, T. (2015). Metabolic syndrome, lifestyle, and dental caries in Japanese school children. *The Bulletin of Tokyo Dental College, 56*(4), 233-241. http://doi.org/10.2209/tdcpublication.56.233	Study design
Osera, T., Awai, M., Kobayashi, M., Tsutie, S., & Kurihara, N. (2017). Relationship between self-rated health and lifestyle and food habits in Japanese high school students. *Behavioral Sciences, 7*(4), 71-80. http://doi.org/10.3390/bs7040071	Study design
O'Sullivan, T. A., Robinson, M., Kendall, G. E., Miller, M., Jacoby, P., Silburn, S. R., & Oddy, W. H. (2009). A good-quality breakfast is associated with better mental health in adolescence. *Public Health Nutrition, 12*(2), 249-258. http://doi.org/10.1017/s1368980008003935	Study design
Overby, N. C., Margeirsdottir, H. D., Brunborg, C., Andersen, L. F., & Dahl-Jorgensen, K. (2007). The influence of dietary intake and meal pattern on blood glucose control in children and adolescents using intensive insulin treatment. *Diabetologia, 50*(10), 2044-2051. http://doi.org/10.1007/s00125-007-0775-0	Study design
Overby, N., & Hoigaard, R. (2012). Diet and behavioral problems at school in Norwegian adolescents. *Food & Nutrition Research, 56*, 17231. http://doi.org/10.3402/fnr.v56i0.17231	Study design

Page, R. M., Simonek, J., Ihasz, F., Hantiu, I., Uvacsek, M., Kalabiska, I., & Klarova, R. (2009). Self-rated health, psychosocial functioning, and other dimensions of adolescent health in Central and Eastern European adolescents. *European Journal of Psychiatry, 23*(2), 101-114. https://doi.org/10.4321/S0213-61632009000200004	Study design
Page, R. M., & Suwanteerangkul, J. (2009). Self-rated health, psychosocial functioning, and health-related behavior among Thai adolescents. *Pediatrics International, 51*(1), 120-125. http://doi.org/10.1111/j.1442-200X.2008.02660.x	Study design
Papoutsou, S., Briassoulis, G., Hadjigeorgiou, C., Savva, S. C., Solea, T., Hebestreit, A., Pala, V., Sieri, S., Kourides, Y., Kafatos, A., & Tornaritis, M. (2014). The combination of daily breakfast consumption and optimal breakfast choices in childhood is an important public health message. *International Journal of Food Science & Nutrition, 65*(3), 273-279. http://doi.org/10.3109/09637486.2013.854750	Study design
Papoutsou, S., Briassoulis, G., Wolters, M., Peplies, J., Iacoviello, L., Eiben, G., Veidebaum, T., Molnar, D., Russo, P., Michels, N., Moreno, L. A., & Tornaritis, M. (2014). No breakfast at home: Association with cardiovascular disease risk factors in childhood. *European Journal of Clinical Nutrition, 68*(7), 829-834. http://doi.org/10.1038/ejcn.2014.88	Study design
Pasic, M. D., Colantonio, D. A., Chan, M. K., Venner, A. A., Brinc, D., & Adeli, K. (2012). Influence of fasting and sample collection time on 38 biochemical markers in healthy children: A CALIPER substudy. *Clinical Biochemistry, 45*(15), 1125-1130. http://doi.org/10.1016/j.clinbiochem.2012.07.089	Study design
Richards, G., & Smith, A. P. (2016). Breakfast and energy drink consumption in secondary school children: Breakfast omission, in isolation or in combination with frequent energy drink use, is associated with stress, anxiety, and depression cross-sectionally, but not at 6-month follow-up. *Frontiers in Psychology, 7* (106). http://doi.org/10.3389/fpsyg.2016.00106	Study design
Richter, M., Erhart, M., Vereecken, C. A., Zambon, A., Boyce, W., & Nic Gabhainn, S. (2009). The role of behavioural factors in explaining socio-economic differences in adolescent health: A multilevel study in 33 countries. *Social Science & Medicine, 69*(3), 396-403. http://doi.org/10.1016/j.socscimed.2009.05.023	Study design
Sakaguchi, K., Yagi, T., Maeda, A., Nagayama, K., Uehara, S., Saito-Sakoguchi, Y., Kanematsu, K., & Miyawaki, S. (2014). Association of problem behavior with sleep problems and gastroesophageal reflux symptoms. *Pediatrics International, 56*(1), 24-30. http://doi.org/10.1111/ped.12201	Study design
Sampasa-Kanyinga, H., & Hamilton, H. A. (2017). Eating breakfast regularly is related to higher school connectedness and academic performance in Canadian middle- and high-school students. *Public Health, 145*, 120-123. http://doi.org/10.1016/j.puhe.2016.12.027	Study design
Sandercock, G. R. H., Cramer, F., & Voss, C. (2010). Associations between school-day breakfast consumption, BMI, physical activity and cardiorespiratory fitness in English schoolchildren. *Proceedings of the Nutrition Society, 69*(OCE1), E55. http://doi.org/10.1017/s0029665109992436	Study design
Sandercock, G. R., Voss, C., & Dye, L. (2010). Associations between habitual school-day breakfast consumption, body mass index, physical activity and cardiorespiratory fitness in English schoolchildren. *European Journal of Clinical Nutrition, 64*(10), 1086-1092. http://doi.org/10.1038/ejcn.2010.145	Study design
Schenker, S. (2008). Eating breakfast is cereally good for your health. *Nursing in Practice* (43), 64-67. Retrieved at: https://www.nursinginpractice.com/article/eating-breakfast-cereally-good-your-health	Study design
Shafiee, G., Kelishadi, R., Qorbani, M., Motlagh, M. E., Taheri, M., Ardalan, G., Taslimi, M., Poursafa, P., Heshmat, R., & Larijani, B. (2013). Association of breakfast intake with cardiometabolic risk factors. *Jornal de Pediatria, 89*(6), 575-582. http://doi.org/10.1016/j.jped.2013.03.020	Study design
Tajik, E., Latiffah, A. L., Awang, H., Siti Nur'Asyura, A., Chin, Y. S., Azrin Shah, A. B., Patricia Koh, C. H., & Mohd Izudin Hariz, C. G. (2016). Unhealthy diet practice and symptoms of stress and depression among adolescents in Pasir Gudang, Malaysia. *Obesity Research & Clinical Practice, 10*(2), 114-123. http://doi.org/10.1016/j.orcp.2015.06.001	Study design

Takasaki, Y. (2005). Serum lipid levels and factors affecting atherogenic index in Japanese children. *Journal of Physiological Anthropology and Applied Human Science, 24*(4), 511-515. http://doi.org/10.2114/jpa.24.511	Study design
Tanihata, T., Kanda, H., Osaki, Y., Ohida, T., Minowa, M., Wada, K., Suzuki, K., & Hayashi, K. (2015). Unhealthy lifestyle, poor mental health, and its correlation among adolescents: A nationwide cross-sectional survey. *Asia Pacific Journal of Public Health, 27*(2), NP1557-NP1565. http://doi.org/10.1177/1010539512452753	Study design
Thivel, D., Aucouturier, J., Isacco, L., Lazaar, N., Ratel, S., Dore, E., Meyer, M., & Duche, P. (2013). Are eating habits associated with physical fitness in primary school children? *Eating Behaviors, 14*(1), 83-86. http://doi.org/10.1016/j.eatbeh.2012.11.002	Study design
Torres-Ferrus, M., Vila-Sala, C., Quintana, M., Ajanovic, S., Gallardo, V. J., Gomez, J. B., Alvarez-Sabin, J., Macaya, A., & Pozo-Rosich, P. (2018). Headache, comorbidities and lifestyle in an adolescent population (The TEENs Study). *Cephalalgia, 39*(1), 91-99. http://doi.org/10.1177/0333102418777509	Study design
Walter, S. (2014). Lifestyle behaviors and illness-related factors as predictors of recurrent headache in U.S. adolescents. *Journal of Neuroscience Nursing, 46*(6), 337-350. http://doi.org/10.1097/jnn.0000000000000095	Study design
Walther, J., Aldrian, U., Stuger, H. P., Kiefer, I., & Ekmekcioglu, C. (2014). Nutrition, lifestyle factors, and mental health in adolescents and young adults living in Austria. *International Journal of Adolescent Medicine & Health, 26*(3), 377-386. http://doi.org/10.1515/ijamh-2013-0310	Study design
Wisting, L., Reas, D. L., Bang, L., Skrivarhaug, T., Dahl-Jorgensen, K., & Ro, O. (2017). Eating patterns in adolescents with type 1 diabetes: Associations with metabolic control, insulin omission, and eating disorder pathology. *Appetite, 114*, 226-231. http://doi.org/10.1016/j.appet.2017.03.035	Study design
Yoshinaga, M., Hatake, S., Tachikawa, T., Shinomiya, M., Miyazaki, A., & Takahashi, H. (2011). Impact of lifestyles of adolescents and their parents on cardiovascular risk factors in adolescents. *Journal of Atherosclerosis and Thrombosis, 18*(11), 981-990. https://doi.org/10.5551/jat.9514	Study design
Zhang, F., Zhao, L., Feng, X., & Hu, X. (2016). An investigation on self-rated health of adolescent students and influencing factors from Sichuan, China. *American Journal of Therapeutics, 23*(5), e1143-e1150. http://doi.org/10.1097/mjt.0000000000000425	Study design

Table A2 4. Articles excluded during full-text screening of the initial literature search for Key Question 2: What best practices exist in the U.S. School Breakfast Program, including models of student costs and breakfast delivery?

Article	**Reason for exclusion**
Morris, C. T., Courtney, A., Bryant, C. A., McDermott, R. J. (2010). Grab N' Go breakfast at school: Observations from a pilot program. Journal of Nutrition Education and Behavior, 42(3), 208-209. http://doi.org/10.1016/j.jneb.2009.10.003	Study design
Ask, A. S., Hernes, S., Aarek, I., Johannessen, G., & Haugen, M. (2006). Changes in dietary pattern in 15 year old adolescents following a 4 month dietary intervention with school breakfast - A pilot study. *Nutrition Journal, 5*(33). https://doi.org/10.1186/1475-2891-5-33	Study setting
Ask, A. S., Hernes, S., Aarek, I., Vik, F., Brodahl, C., & Haugen, M. (2010). Serving of free school lunch to secondary-school pupils - A pilot study with health implications. *Public Health Nutrition, 13*(2): 238-244. https://doi.org/10.1017/S1368980009990772	Study setting

Briggs, L., & Menger, B. (2011). Improving nutrition at breakfast and after school clubs. *Journal of Human Nutrition & Dietetics, 24*(4): 379-379. https://doi.org/10.1111/j.1365-277X.2011.01177_6.x	Study setting
Defeyter, M. A., Graham, P. L., & Russo, R. (2015). More than just a meal: Breakfast club attendance and children's social relationships. *Frontiers in Public Health, 3*(183). http://doi.org/10.3389/fpubh.2015.00183	Study setting
Mhurchu, C. N., Turley, M., Gorton, D., Jiang, Y., Michie, J. Maddison, R., & Hattie, J. (2010). Effects of a free school breakfast programme on school attendance, achievement, psychosocial function, and nutrition: A stepped wedge cluster randomised trial. *BMC Public Health, 10*, 738. http://doi.org/10.1186/1471-2458-10-738	Study setting
Muthayya, S., Thomas, T., Srinivasan, K., Rao K., Kurpad, A. V., van Klinken, J. W., Owen, G., & de Bruin, E. A. (2007). Consumption of a mid-morning snack improves memory but not attention in school children. *Physiology & Behavior, 90*(1), 142-150. https://doi.org/10.1016/j.physbeh.2006.09.025	Study setting
Watanabe, J., Watanabe, M., Koga, M., Yamaoka, K., Yokotsuka, M., Adachi, M., Hashimoto, Y., & Tango, T. (2013). Effects of dietary lifestyle education program for adolescents in middle schools: Study design of a cluster randomized controlled trial. *Annals of Nutrition and Metabolism, 63*, 726-727. https://doi.org/10.1371/journal.pone.0165285	Study setting
Askelson, N. M., Golembiewski, E. H., Ghattas, A., Williams, S., Delger, P. J., & Scheidel, C. A. (2017). Exploring the parents' attitudes and perceptions about school breakfast to understand why participation is low in a rural midwest state. *Journal of Nutrition Education and Behavior, 49*(2), 107-116.e1. http://doi.org/10.1016/j.jneb.2016.10.011	Intervention, exposure, or comparator
Au, L. E., Gurzo, K., Gosliner, W., Webb, K. L., Crawford, P. B., & Ritchie, L. D. (2018). Eating school meals daily is associated with healthier dietary intakes: The Healthy Communities Study. *Journal of the Academy of Nutrition and Dietetics, 118*(8), 1474-1481.e1. http://doi.org/10.1016/j.jand.2018.01.010	Intervention, exposure, or comparator
Bartfeld, J. S., & Ahn, H. M. (2011). The School Breakfast Program strengthens household food security among low-income households with elementary school children. *Journal of Nutrition, 141*(3), 470-475. http://doi.org/10.3945/jn.110.130823	Intervention, exposure, or comparator
Bartfeld, J. S., & Ryu, J. H. (2011). The School Breakfast Program and breakfast-skipping among Wisconsin elementary school children. *Social Service Review, 85*(4), 619-634. https://doi.org/10.1086/663635	Intervention, exposure, or comparator
Baxter, S. D., Paxton-Aiken, A. E., Tebbs, J. M., Royer, J. A., Guinn, C. H., & Finney, C. J. (2012). Secondary analyses of data from 4 studies with fourth-grade children show that sex, race, amounts eaten of standardized portions, and energy content given in trades explain the positive relationship between body mass index and energy intake at school-provided meals. *Nutrition Research, 32*(9), 659-668. http://doi.org/10.1016/j.nutres.2012.07.001	Intervention, exposure, or comparator
Baxter, S. D., Royer, J. A., Hardin, J. W., Guinn, C. H., & Smith, A. F. (2007). Fourth-grade children are less accurate in reporting school breakfast than school lunch during 24-hour dietary recalls. *Journal of Nutrition Education and Behavior, 39*(3), 126-133. http://doi.org/10.1016/j.jneb.2006.12.014	Intervention, exposure, or comparator
Bhattacharya, J., Currie, J., & Haider, S. J. (2006). Breakfast of champions? The school breakfast program and the nutrition of children and families. *Journal of Human Resources, 41*(3), 445-466. http://doi.org/10.3368/jhr.XLI.3.445	Intervention, exposure, or comparator
Bruening, M., Larson, N., Story, M., Neumark-Sztainer, D., & Hannan, P. (2011). Predictors of adolescent breakfast consumption: Longitudinal findings from Project EAT. *Journal of Nutrition Education and Behavior, 43*(5), 390-395. http://doi.org/10.1016/j.jneb.2011.02.016	Intervention, exposure, or comparator
Centeio, E. E., Somers, C. L., Moore, E. W. G., Kulik, N., Garn, A., Martin, J., McCaughtry, N. (2018). Relationship between academic achievement and healthy school transformations in urban elementary schools in the United States. *Physical Education and Sport Pedagogy, 23*(4), 402-417. https://doi.org/10.1080/17408989.2018.1441395	Intervention, exposure, or comparator

Clark, M. A., & Fox, M. K. (2009). Nutritional quality of the diets of US public school children and the role of the school meal programs. *Journal of the American Dietetic Association, 109* (2 Supplement), S44-S56. http://doi.org/10.1016/j.jada.2008.10.060	Intervention, exposure, or comparator
Condon, E. M., Crepinsek, M. K., & Fox, M. K. (2009). School meals: types of foods offered to and consumed by children at lunch and breakfast. *Journal of the American Dietetic Association, 109* (2 Supplement), S67-S78. http://doi.org/10.1016/j.jada.2008.10.062	Intervention, exposure, or comparator
Crawford, P. B., Woodward-Lopez, G., Gosliner, W., & Webb, K. (2013). Lessons of Fresh Start can guide schools seeking to boost student fruit consumption. *California Agriculture, 67*(1) 21-29. https://doi.org/10.3733/ca.v067n01p21	Intervention, exposure, or comparator
Cullen, K. W., & Chen, T. A. (2016). The contribution of the USDA school breakfast and lunch program meals to student daily dietary intake. *Preventive Medicine Reports, 5*, 82-85. https://doi.org/10.1016/j.pmedr.2016.11.016	Intervention, exposure, or comparator
Dave, J. M., Chen, T. A., Oceguera, A., M., Cullen, K. W., & Thompson, D. I. (2015). Outcome evaluation of a pilot study using nudges. *International Journal of Child Health and Nutrition, 4*(1), 33-39. https://doi.org/10.6000/1929-4247.2015.04.01.3	Intervention, exposure, or comparator
Dykstra, H., Davey, A., Fisher, J. O., Polonsky, H., Sherman, S., Abel, M. L., Dale, L. C., Foster, G. D., & Bauer, K. W. (2016). Breakfast-skipping and selecting low-nutritional-quality foods for breakfast are common among low-income urban children, regardless of food security status. *Journal of Nutrition, 146*(3), 630-636. http://doi.org/10.3945/jn.115.225516	Intervention, exposure, or comparator
Fletcher, J. M., & Frisvold, D. E. (2017). The relationship between the School Breakfast Program and food insecurity. *Journal of Consumer Affairs, 51*(), 481-500. https://doi.org/10.1111/joca.12163	Intervention, exposure, or comparator
Frisvold, D. E. (2015). Nutrition and cognitive achievement: An evaluation of the school breakfast program. *Journal of Public Economics, 124,* 91-104. http://doi.org/10.1016/j.jpubeco.2014.12.003	Intervention, exposure, or comparator
Gu, X., & Tucker, K. L. (2017). Dietary quality of the US child and adolescent population: Trends from 1999 to 2012 and associations with the use of federal nutrition assistance programs. American Journal of Clinical Nutrition, 105(1), 194-202. http://doi.org/10.3945/ajcn.116.135095	Intervention, exposure, or comparator
Guinn, C. H., Baxter, S. D., Royer, J. A., Hitchcock, D. B. (2013). Explaining the positive relationship between fourth-grade children's body mass index and energy intake at school-provided meals (breakfast and lunch). *Journal of School Health, 83*(5) 328-334. http://doi.org/10.1111/josh.12035	Intervention, exposure, or comparator
HEALTHY Study Group, Mobley, C. C., Stadler, D. D., Staten, M. A., El Ghormli, L., Gillis, B., Hartstein, J., Siega-Riz, A. M., & Virus, A. (2012). Effect of nutrition changes on foods selected by students in a middle school-based diabetes prevention intervention program: The HEALTHY experience. *Journal of School Health, 82*(2), 82-90. http://doi.org/10.1111/j.1746-1561.2011.00670.x	Intervention, exposure, or comparator
Hearst, M. O., Shanafelt, A., Wang, Q., Leduc, R., & Nanney, M. S. (2016). Barriers, benefits, and behaviors related to breakfast consumption among rural adolescents. *Journal of School Health, 86*(3), 187-194. http://doi.org/10.1111/josh.12367	Intervention, exposure, or comparator
Heo, M., Irvin, E., Ostrovsky, N., Isasi, C., Blank, A. E., Lounsbury, D. W., Fredericks, L., Yom, T., Ginsberg, M., Hayes, S., & Wylie-Rosett, J. (2016). Behaviors and knowledge of Healthcorps New York City high school students: Nutrition, mental health, and physical activity. *Journal of School Health, 86*(2), 84-95. http://doi.org/10.1111/josh.12355	Intervention, exposure, or comparator
Hoelscher, D. M., Moag-Stahlberg, A., Ellis, K., Vandewater, E. A., & Malkani, R. (2016). Evaluation of a student participatory, low-intensity program to improve school wellness environment and students' eating and activity behaviors. *International Journal of Behavioral Nutrition and Physical Activity, 13*, 13-59. http://doi.org/10.1186/s12966-016-0379-5	Intervention, exposure, or comparator
Hofferth, S. L., & Curtin, S. (2005). Poverty, food programs, and childhood obesity. *Journal of Policy Analysis and Management, 24*(4), 703-726. https://doi.org/10.1002/pam.20134	Intervention, exposure, or comparator

Irwin, C., Irwin, R., Richey, P., Miller, M., Boddie, J., & Dickerson, T (2012). Get fit with the Grizzlies: A community-school-home initiative to fight childhood obesity led by a professional sports organization. *Studies in Health Technology and Informatics, 172*, 163-167. http://doi.org/10.3233/978-1-61499-088-8-163	Intervention, exposure, or comparator
Ishdorj, A., Crepinsek, M. K., & Jensen, H. H. (2013). Children's consumption of fruits and vegetables: Do school environment and policies affect choices at school and away from school? *Applied Economic Perspectives and Policy, 35*(2), 341-359. https://doi.org/10.1093/aepp/ppt003	Intervention, exposure, or comparator
Kim, N., Seo, D. C., King, M. H., Lederer, A. M., & Sovinski, D. (2014). Long-term predictors of blood pressure among adolescents during an 18-month school-based obesity prevention intervention. *Journal of Adolescent Health, 55*(4), 521-527. http://doi.org/10.1016/j.jadohealth.2014.04.011	Intervention, exposure, or comparator
Kimbro, R. T., & Rigby, E. (2010). Federal food policy and childhood obesity: A solution or part of the problem? *Health Affairs, 29*(3), 411-418. https://doi.org/10.1377/hlthaff.2009.0731	Intervention, exposure, or comparator
Larsen, A. L., Liao, Y., Alberts, J., Huh, J., Robertson, T., & Dunton, G. F. (2017). RE-AIM Analysis of a school-based nutrition education intervention in kindergarteners. *Journal of School Health, 87*(1), 36-46. http://doi.org/10.1111/josh.12466	Intervention, exposure, or comparator
Lawman, H. G., Polonsky, H. M., Vander Veur, S. S., Abel, M. L., Sherman, S., Bauer, K. W., Sanders, T., Fisher, J. O., Bailey-Davis, L., Ng, J., Van Wye, G., & Foster, G. D. (2014). Breakfast patterns among low-income, ethnically-diverse 4th-6th grade children in an urban area. *BMC Public Health, 14*, 604. http://doi.org/10.1186/1471-2458-14-604	Intervention, exposure, or comparator
Miller, D. P. (2011). Associations between the home and school environments and child body mass index. *Social Science & Medicine, 72*(5), 677-684. http://doi.org/10.1016/j.socscimed.2010.12.003	Intervention, exposure, or comparator
Millimet, D. L., Tchernis, R., & Husain, M. (2010). School nutrition programs and the incidence of childhood obesity. *Journal of Human Resources, 45*, 640-654. https://doi.org/10.3386/w14297	Intervention, exposure, or comparator
Millimet, D. L., & Tchernis, R. (2013). Estimation of treatment effects without an exclusion restriction: With an application to the analysis of the School Breakfast Program. *Journal of Applied Econometrics, 28*(), 982-1017. https://doi.org/10.3386/w15539	Intervention, exposure, or comparator
Montgomery-Reagan, K., Bianco, J. A., Heh, V., Rettos, J., & Huston, R. S. (2009). Prevalence and correlates of high body mass index in rural Appalachian children aged 6-11 years. Rural Remote Health, 9(4), 1234. PMID: 19848443	Intervention, exposure, or comparator
Peart, T., Kao, J., Crawford, P. B., Samuels, S. E., Craypo, L., & Woodward-Lopez, G. (2012). Does competitive food and beverage legislation hurt meal participation or revenues in high schools? *Child Obesity, 8*(4), 339-346. http://doi.org/10.1089/chi.2012.0009	Intervention, exposure, or comparator
Polonsky, H. M., Davey, A., Bauer, K. W., Foster, G. D., Sherman, S., Abel, M. L., Dale, L. C., & Fisher, J. O (2018). Breakfast quality varies by location among low-income ethnically diverse children in public urban schools. *Journal of Nutrition Education and Behavior, 50*(2), 190-197.e1. http://doi.org/10.1016/j.jneb.2017.09.009	Intervention, exposure, or comparator
Quick, V., Wall, M., Larson, N., Haines, J., & Neumark-Sztainer, D. (2013). Personal, behavioral and socio-environmental predictors of overweight incidence in young adults: 10-yr longitudinal findings. *International Journal of Behavioral Nutrition and Physical Activity, 10*, 37. http://doi.org/10.1186/1479-5868-10-37	Intervention, exposure, or comparator
Reich, S. M., Kay, J. S., & Lin, G. C. (2015). Nourishing a partnership to improve middle school lunch options a community-based participatory research project. *Family & Community Health, 38*(1), 77-86. https://doi.org/10.1097/fch.0000000000000055	Intervention, exposure, or comparator
Robinson-O'Brien, R., Burgess-Champoux, T., Haines, J., Hannan, P. J., & Neumark-Sztainer, D. (2010). Associations between school meals offered through the National School Lunch Program and the School Breakfast Program and fruit and vegetable intake among ethnically diverse, low-income children. *Journal of School Health, 80*(10), 487-492. http://doi.org/10.1111/j.1746-1561.2010.00532.x	Intervention, exposure, or comparator

Rosas, S., Case, J., & Tholstrup, L. (2009). A retrospective examination of the relationship between implementation quality of the coordinated school health program model and school-level academic indicators over time. *Journal of School Health, 79*(3), 108-115. https://doi.org/10.1111/j.1746-1561.2008.00394.x	Intervention, exposure, or comparator
Smith, T. A. (2017). Do school food programs improve child dietary quality? *American Journal of Agricultural Economics, 99*(2), 339-356. https://doi.org/10.1093/ajae/aaw091	Intervention, exposure, or comparator
Sweeney, N. M., & Horishita, N. (2005). The breakfast-eating habits of inner city high school students. *Journal of School Nursing, 21*(2), 100-105. http://doi.org/10.1177/10598405050210020701	Intervention, exposure, or comparator
Trude, A. C., Kharmats, A. Y., Hurley, K. M., Anderson Steeves, E., Talegawkar, S. A., & Gittelsohn, J. (2016). Household, psychosocial, and individual-level factors associated with fruit, vegetable, and fiber intake among low-income urban African American youth. *BMC Public Health, 16*(1), 872. http://doi.org/10.1186/s12889-016-3499-6	Intervention, exposure, or comparator
Vericker, T. C. (2014). Children's school-related food and physical activity behaviors are associated with body mass index. *Journal of the Academy of Nutrition and Dietetics, 114*(2), 250-256. http://doi.org/10.1016/j.jand.2013.07.046	Intervention, exposure, or comparator
Wang, S., Schwartz, M. B., Shebl, F. M., Read, M., Henderson, K. E., & Ickovics, J. R. (2017). School breakfast and body mass index: A longitudinal observational study of middle school students. *Pediatric Obesity, 12*(3), 213-220. http://doi.org/10.1111/ijpo.12127	Intervention, exposure, or comparator
Williams, B. M., O'Neil, C. E., Keast, D. R., Cho, S., & Nicklas, T. A. (2009). Are breakfast consumption patterns associated with weight status and nutrient adequacy in African-American children? *Public Health Nutrition, 12*(4), 489-496. http://doi.org/10.1017/S1368980008002760	Intervention, exposure, or comparator
Williamson, D. A., Han, H., Johnson, W. D., Martin, C. K., & Newton, R. L., Jr. (2013). Modification of the school cafeteria environment can impact childhood nutrition. Results from the Wise Mind and LA Health studies. *Appetite, 61*(1), 77-84. http://doi.org/10.1016/j.appet.2012.11.002	Intervention, exposure, or comparator
Diaz, T., Ficapal-Cusi, P., & Aguilar-Martinez, A. (2016). Breakfast habits in primary and secondary schoolchildren: Options for nutritional education in schools. Nutricion Hospitalaria, 33(4), 909-914. https://doi.org/10.20960/nh.391	Language of publication
Amaya, Lauren, Gates, G. (2015). Evaluation of the promotion of free school breakfast on consumption and perceptions of school breakfast in a rural district. *Journal of Nutrition Education & Behavior, 47*(4), S75. https://doi.org/10.1016/j.jneb.2015.04.198	Study design
Ask, A. S., Hernes, S., Aarek, I., Johannessen, G., & Haugen, M. (2006). Changes in dietary pattern in 15 year old adolescents following a 4 month dietary intervention with school breakfast--a pilot study. *Nutrition Journal, 5,* 33. http://doi.org/10.1186/1475-2891-5-33	Study design
Baxter, S., Hitchcock, D. B., Smith, A. F., Finney, C. J., Guinn, C. H., & Royer, J. A. (2016). As children’s body mass index percentile increased, they ate more kilocalories at school-provided breakfast and lunch, but did not report more kilocalories at the same rate. *Journal of the Academy of Nutrition & Dietetics, 116*(9 Supplement), A72. https://doi.org/10.1016/j.jand.2016.06.250	Outcome
Cubero, J., Franco-Reynolds, L., Calderon, M. A., Caro, B., Rodrigo, M., & Ruiz, C. (2017). School breakfast, an educative intervention in healthy food and nutrition. *Didactica De Las Ciencias Experimentales Y Sociales,* (32), 171-182.	Study design
Fernandez, A. C., Weigand, C. M., Pomar, M. D. B., Casariego, A. V., Gómez, J. J. L., Rodríguez, I. C., Arias, M. T. G., & Fernández, M. C. G. (2011). Changes on dietary habits of the late-breakfast in a school population. *Nutricion Hospitalaria, 26*(3), 560-565. http://doi.org/10.1590/S0212-16112011000300019	Intervention, exposure, or comparator
Fisher, J. O., Polonsky, H., Bauer, K., Sherman, S., Abel, M., Vander Veur, S., & Foster, G. (2015). Increasing breakfast consumption and decreasing childhood obesity in low-income, ethnically diverse	Publication status

youth. *Journal of Nutrition Education & Behavior, 47*(4 Supplement), S99. https://doi.org/10.1016/j.jneb.2015.04.266	
Gates, G., & Perera, T. (2013). Association between breakfast consumption and nutritional status in 9 to 13 year old children. *Journal of Nutrition Education & Behavior, 45*(4 Supplement), S31. https://doi.org/10.1016/j.jneb.2013.04.084	Publication status
Hearst, M. O., Shanafelt, A., Wang, Q., Leduc, R., & Nanney, M. S. (2018). Altering the school breakfast environment reduces barriers to school breakfast participation among diverse rural youth. *Journal of School Health, 88*(1), 3-8. http://doi.org/10.1111/josh.12575	Outcomes
Krueger, E. B., Eggett, D. L., & Stokes, N. (2018). Teacher perceptions and preferences for 5 school breakfast program models. *Journal of Nutrition Education and Behavior, 50*(8), 788-794. http://doi.org/10.1016/j.jneb.2018.01.006	Outcomes
Rives, F. M., Marin, F. M., Rives, L. V. M., & Garralda, G. M. Á. (2015). Pharmaceutical care for healthy breakfast promotion in community pharmacies. *Nutricion Hospitalaria, 32*(3), 1267-1272. http://doi.org/10.3305/nh.2015.32.3.9390	Intervention, exposure, or comparator
Traub, M., Steinacker, J. M., Kesztyus, D., & Arbeitsgrp Komm Gesunde Boot. (2017). Avoiding breakfast for the primary school children cofactors as an important basis for targeted prevention measures. *Ernahrungs Umschau, 64*, 9. https://doi.org/10.4455/eu.2017.035	Intervention, exposure, or comparator
Wixom, N., Walther, C., Urbach, K., & Yussman, S. M. (2018). 242 - Introduction of a breakfast in the classroom program in an urban middle school. *Journal of Adolescent Health, 62*(2), S123. https://doi.org/10.1016/j.jadohealth.2017.11.250	Study design
Baxter, S. D., Guinn, C. H., Royer, J. A., Hardin, J. W., Mackelprang, A. J., & Smith, A. F. (2009). Accuracy of children's school-breakfast reports and school-lunch reports (in 24-h dietary recalls) differs by retention interval. *European Journal of Clinical Nutrition, 63*(12), 1394-1403. http://doi.org/10.1038/ejcn.2009.107	Outcome
Baxter, S. D., Guinn, C. H., Smith, A. F., Hitchcock, D. B., Royer, J. A., Puryear, M. P., Collins, K. L., & Smith, A. L. (2016). Children's school-breakfast reports and school-lunch reports (in 24-h dietary recalls): Conventional and reporting-error-sensitive measures show inconsistent accuracy results for retention interval and breakfast location. *British Journal of Nutrition, 115*(7), 1301-1315. http://doi.org/10.1017/S0007114515005413	Outcome
Nanney, M. S., Shanafelt, A., Wang, Q., Leduc, R., Dodds, E., Hearst, M., Kubik, M. Y., Grannon, K., & Harnack, L. (2016). Project BreakFAST: Rationale, design, and recruitment and enrollment methods of a randomized controlled trial to evaluate an intervention to improve School Breakfast Program participation in rural high schools. *Contemporary Clinical Trials Communications, 3*, 12-22. http://doi.org/10.1016/j.conctc.2015.12.009	Outcome
Ollinger, M., Ralston, K., & Guthrie, J. (2012). Location, school characteristics, and the cost of school meals. *Journal of Agricultural and Resource Economics, 37*(3), 379-397. https://www.jstor.org/stable/23496723	Outcome
Poblacion, A., Cook, J., de Cuba, S. E., Bovell, A., Sheward, R., Pasquariello, J., & Cutts, D. (2017). Can food insecurity be reduced in the United States by improving SNAP, WIC, and the Community Eligibility Provision? *World Medical & Health Policy, 9*(4), 435-455. https://doi.org/10.1002/wmh3.248	Outcome
Askelson, N. M., Golembiewski, E. H., Bobst, A., Delger, P. J., & Scheidel, C. A. (2017). Understanding perceptions of school administrators related to school breakfast in a low school breakfast participation state. *Journal of School Health, 87*(6), 427-434. http://doi.org/10.1111/josh.12511	Study setting
Khodabocus, R., Tran, K., Broom, T., & Razaq, A. (2015). Breakfast club: a simple, reproducible, student education initiative. *Medical Education, 49*(11), 1143-1144. http://doi.org/10.1111/medu.12879	Study setting
Knoblock-Hahn, A., Brown, K., Medrow, L., & Murphy, A. (2016). How community food banks support school breakfast: Strategies used and lessons learned. *Journal of the Academy of Nutrition & Dietetics, 116*(7), 1187-1192. https://doi.org/10.1016/j.jand.2016.01.013	Population

Spruance, L. A., Harrison, C., Brady, P., Woolford, M., & LeBlanc, H. (2018). Who eats school breakfast? Parent perceptions of school breakfast in a state with very low participation. *Journal of School Health, 88*(2), 139-149. http://doi.org/10.1111/josh.12597	Study design
Access to breakfast clubs vital for parents.(2014). British Journal of School Nursing,9: 59-59. https://doi.org/10.12968/bjsn.2014.9.2.57.	Study design
Breakfast in the Classroom: An Investment Today for our Kid's Future.(2010). New York Family Medicine News, 4-4.	Study design
Breakfast in the Classroom: An investment today for our kids' future. (2012). New York Family Medicine News, 7-7.	Study design
Conjuring up breakfast for children. (2008). Practice Nurse, 4-4.	Study design
Askelson, N. M., Golembiewski, E. H., DePriest, A. M., O'Neill, P., Delger, P. J., Scheidel, C. A. (2015). The answer isn't always a poster: Using social marketing principles and concept mapping with high school students to improve participation in school breakfast. *Social Marketing Quarterly, 21*(3), 119-134. https://doi.org/10.1177/1524500415589591	Study design
Cowbrough, K. (2014). Early breakfast challenges. Journal of Family Health Care, 24(7), 23-24. PMID: 25668970	Study design
Creighton, L. S. (2012). Stakeholder engagement for successful breakfast in the classroom implementation. *Journal of School Health, 82*(11), 496-498. http://doi.org/10.1111/j.1746-1561.2012.00728.x	Study design
Egner, R., Oza-Frank, R., & Cunningham, S. A. (2014). The school breakfast program: A view of the present and preparing for the future-a commentary. *Journal of School Health, 84*(7), 417-420. http://doi.org/10.1111/josh.12164	Study design
French, S. A., & Story, M. (2013). Commentary on nutrition standards in the national school lunch and breakfast programs. *JAMA Pediatrics, 167*(1), 8-9. http://doi.org/10.1001/jamapediatrics.2013.639	Study design
Gundersen, C. (2015). Food assistance programs and child health. *Future of Children, 25*(1), 91-109. https://doi.org/10.1353/foc.2015.0004	Study design
Heller, E., & Johnson, T. (2016). Healthy foods in schools. *National Conference of State Legislature Legisbrief, 24*(22), 1-2.	Study design
Lepkowska, D. (2015). The importance of a healthy breakfast to start the school day. *British Journal of School Nursing, 10*(4), 171-174. https://doi.org/10.12968/bjsn.2015.10.4.171	Study design
Marcason, W. (2012). What are the new national school lunch and breakfast program nutrition standards? *Journal of the Academy of Nutrition and Dietetics, 112*(7), 1112. https://doi.org/10.1016/j.jand.2012.05.017	Study design
Marcason, W. (2008). Where can I find information and resources for the School Breakfast Program?. *Journal of the American Dietetic Association, 108*(9), 1580. http://doi.org/10.1016/j.jada.2008.07.032	Study design
Ohr, L. M. (2016). Ingredients for Healthy Adolescents. *Food Technology, 70*(8).	Study design
Precht, T. E., Strassner, C., & Kral, T. V. E. (2014). School breakfast - what can Germany learn from the US experience? *Ernahrungs Umschau, 61*(2), 20-26. http://doi.org/10.4455/eu.2014.004	Study design
Ruxton, C. (2011). *Breakfast clubs: The nutritional, social and health benefits.* Nursing in Practice. Retrieved at: https://www.nursinginpractice.com/article/breakfast-clubs-nutritional-social-and-health-benefits	Study design

Schwaab, B., Fettweis, C., & Caplon, M. (2012). Increasing student breakfast consumption: An established model in Maryland. Interview by Jodi R. Godfrey. *Child Obesity, 8*(2), 162-166. http://doi.org/10.1089/chi.2012.0082.godf	Study design
Story, M., Kaphingst, K. M., & French, S. (2006). The role of schools in obesity prevention. *The Future of Children, 16*(1), 109-142. http://doi.org/10.1353/foc.2006.0007	Study design
Zilberter, T., & Zilberter, E. Y. (2013). Breakfast and cognition: Sixteen effects in nine populations, no single recipe. *Frontiers in Human Neuroscience, 7*(631). http://doi.org/10.3389/fnhum.2013.00631	Study design

Table A2 5. Articles excluded during full-text screening of the updated literature search for all rapid review questions

Article	**Reason for exclusion**
Morgenmadsklubben (the breakfast club). ISRCTN11265280 2018. https://www.cochranelibrary.com/central/doi/10.1002/central/CN-01949949/full	Publication status
School children's breakfast consumption: An educational intervention based on social cognitive theory. Annals of tropical medicine and public health. 2018;(11):SP36.	Outcome
A training intervention based on the social marketing model in promoting healthy breakfast and snack. IRCT20170201032347N1. 2018. https://www.cochranelibrary.com/central/doi/10.1002/central/CN-01951001/full	Publication status
Acute effects of breakfast compared with no breakfast on cognitive function and subjective state in 11-13 year old children. NCT03979027. 2019. https://www.cochranelibrary.com/central/doi/10.1002/central/CN-01945391/full	Publication status
Nutrition education potentially improves breakfast quality of adolescents from low-mid socioeconomic background. Ann Nutr Metab. 2019;75(3):186.	Publication status
Erratum: Effect of a breakfast in the classroom initiative on obesity in urban school-aged children: A cluster randomized clinical trial (JAMA Pediatr (2019) DOI: 10.1001/jamapediatrics.2018.5531). JAMA Pediatr. 2019;173(7):704.	Study design
The 3 Healthy Study for obesity prevention among vulnerable children. ISRCTN11347525. 2019. https://www.cochranelibrary.com/central/doi/10.1002/central/CN-01974155/full	Publication status
Metabolic responses to breakfast in adolescent girls. NCT04476693. 2020. https://www.cochranelibrary.com/central/doi/10.1002/central/CN-02145352/full	Publication status
Breakfast omission and energy balance in girls. NCT04481776. 2020. https://www.cochranelibrary.com/central/doi/10.1002/central/CN-02145467/full	Publication status
Study on the effects of dietary education on the basis of breakfast intake of schoolchildren for different subjects. JPRN-UMIN000040336. 2020. https://www.cochranelibrary.com/central/doi/10.1002/central/CN-02172953/full	Publication status, Outcome
Dietary Habits and Metabolic Response in Obese Children Whose Mothers Received an Intervention to Promote Healthy Eating. NCT04374292. 2020. https://clinicaltrials.gov/ct2/show/NCT04374292	Publication status
Adolphus K, Lawton CL, Dye L. Associations between habitual school-day breakfast consumption frequency and academic performance in British adolescents. Front Public Health. 2019;7:283. doi:10.3389/fpubh.2019.00283	Study design

Agostini A, Lushington K, Kohler M, Dorrian J. Associations between self-reported sleep measures and dietary behaviours in a large sample of Australian school students (n = 28,010). J Sleep Res. Oct 2018;27(5):e12682. doi:10.1111/jsr.12682	Intervention/exposure
Al-Hazzaa HM, Al-Rasheedi AA, Alsulaimani RA, Jabri L. Anthropometric, familial- and lifestyle-related characteristics of school children skipping breakfast in Jeddah, Saudi Arabia. Nutrients. Nov 29 2020;12(12)doi:10.3390/nu12123668	Study design
Al-Hazzaa HM, Alhowikan AM, Alhussain MH, Obeid OA. Breakfast consumption among Saudi primary-school children relative to sex and socio-demographic factors. BMC Public Health. Apr 6 2020;20(1):448. doi:10.1186/s12889-020-8418-1	Study design
Allara E, Angelini P, Gorini G, et al. Effects of a prevention program on multiple health-compromising behaviours in adolescence: A cluster randomized controlled trial. Prev Med. Jul 2019;124:1-10. doi:10.1016/j.ypmed.2019.04.001	Outcome
Alsharairi NA, Somerset S. Parental work status and children's dietary consumption: Australian evidence. International Journal of Consumer Studies. Sep 2018;42(5):522-532. doi:10.1111/ijcs.12463	Intervention/exposure, Outcome
Altay N, Toruner EK, Akgun-Citak E. Determine the BMI levels, self-concept and healthy life behaviours of children during a school based obesity training programme. AIMS Public Health. 2020;7(3):535-547. doi:10.3934/publichealth.2020043	Design, Intervention/exposure
Arenaza L, Medrano M, Oses M, et al. The effect of a family-based lifestyle education program on dietary habits, hepatic fat and adiposity markers in 8-12-year-old children with overweight/obesity. Nutrients. May 16 2020;12(5)doi:10.3390/nu12051443	Study design
Arenaza L, Munoz-Hernandez V, Medrano M, et al. Association of breakfast quality and energy density with cardiometabolic risk factors in overweight/obese children: Role of physical activity. Nutrients. Aug 10 2018;10(8)doi:10.3390/nu10081066	Study design
Bani-Issa W, Dennis CL, Brown HK, et al. The influence of parents and schools on adolescents' perceived diet and exercise self-efficacy: A school-based sample from the United Arab Emirates. J Transcult Nurs. Sep 2020;31(5):479-491. doi:10.1177/1043659619876686	Outcome
Bardin S, Gola AA. Analyzing the association between student weight status and school meal participation: Evidence from the School Nutrition and Meal Cost Study. Nutrients. Dec 23 2020;13(1)doi:10.3390/nu13010017	Intervention/exposure
Barstad LH, Juliusson PB, Johnson LK, Hertel JK, Lekhal S, Hjelmesaeth J. Gender-related differences in cardiometabolic risk factors and lifestyle behaviors in treatment-seeking adolescents with severe obesity. BMC Pediatr. Feb 14 2018;18(1):61. doi:10.1186/s12887-018-1057-3	Study design
Bartfeld JS, Berger L, Men F. Universal access to free school meals through the community eligibility provision is associated with better attendance for low-income elementary school students in Wisconsin. J Acad Nutr Diet. Feb 2020;120(2):210-218. doi:10.1016/j.jand.2019.07.022	Intervention/exposure
Bastami F, Arash A, Fereshteh Z-A, Mostafavi F. Explaining the dimensions of social support for breakfast and healthy snacks in students: A qualitative study. Int J Adolesc Med Health. Nov 2 2020;34(2):59-66. doi:10.1515/ijamh-2019-0249	Study design
Bernabe-Ortiz A, Carrillo-Larco RM. Longitudinal association between food frequency and changes in body mass index: A prospective cohort study. BMJ Open. 2020;10(9)doi:10.1136/bmjopen-2020-037057	Intervention/exposure
Blasetti A, Franchini S, Castorani V, et al. Skipping breakfast is associated with an atherogenic lipid profile in overweight and obese prepubertal children. Int J Endocrinol. 2020;2020:1849274. doi:10.1155/2020/1849274	Study design

Blaszczyk-Bebenek E, Piorecka B, Plonka M, et al. Risk factors and prevalence of abdominal obesity among upper-secondary students. Int J Environ Res Public Health. May 17 2019;16(10)doi:10.3390/ijerph16101750	Study design
Bleiweiss-Sande R, Chui K, Wright C, Amin S, Anzman-Frasca S, Sacheck JM. Associations between food group intake, cognition, and academic achievement in elementary schoolchildren. Nutrients. Nov 2019;11(11):2722. doi:10.3390/nu11112722	Intervention/exposure
Boutelle KN, Manzano MA, Strong DR, Rhee KE. Evaluating the acceptability and feasibility of providing egg or cereal breakfast during a family-based treatment for children with overweight/obesity: The Families and Breakfast Pilot Trial. Child Obes. Dec 2019;15(8):502-509. doi:10.1089/chi.2018.0331	Design, Comparator
Cao R, Gao T, Ren H, et al. Unique and cumulative effects of lifestyle-related behaviors on depressive symptoms among Chinese adolescents. Int J Soc Psychiatry. Mar 2022;68(2):354-364. doi:10.1177/0020764021996739	Study design
Centeio EE, Somers CL, Moore EWG, et al. Relationship between academic achievement and healthy school transformations in urban elementary schools in the United States. Phys Educ Sport Peda. 2018;23(4):402-417. doi:10.1080/17408989.2018.1441395	Intervention/exposure
Chen CY, Hsiao YC. Dual trajectories of breakfast eating and fruit and vegetable intake over a 5-year follow-up period among economically disadvantaged children: Gender differences. Appetite. Feb 1 2018;121:41-49. doi:10.1016/j.appet.2017.10.027	Outcome
Christensen CB, Mikkelsen BE, Toft U. The effect of introducing a free breakfast club on eating habits among students at vocational schools. BMC Public Health. Apr 3 2019;19(1):369. doi:10.1186/s12889-019-6701-9	Outcome
Cohen TR, Hazell TJ, Vanstone CA, Rodd C, Weiler HA. Changes in eating behavior and plasma leptin in children with obesity participating in a family-centered lifestyle intervention. Appetite. Jun 1 2018;125:81-89. doi:10.1016/j.appet.2018.01.017	Study design
Critch JN. School nutrition: Support for providing healthy food and beverage choices in schools. Paediatr Child Health. Feb 2020;25(1):33-46. doi:10.1093/pch/pxz102	Study design
De Cnop ML, Monteiro LS, Rodrigues PRM, Estima CCP, Veiga GV, Pereira RA. Meal habits and anthropometric indicators in adolescents from public and private schools of the metropolitan region of Rio de Janeiro. Revista De Nutricao-Brazilian Journal of Nutrition. Jan-Feb 2018;31(1):35-47.	Study design
de Souza MR, Neves MEA, Souza AM, et al. Skipping breakfast is associated with the presence of cardiometabolic risk factors in adolescents: Study of Cardiovascular Risks in Adolescents - ERICA. Br J Nutr. Jul 28 2021;126(2):276-284. doi:10.1017/S0007114520003992	Study design
Deavin N, McMahon AT, Walton K, Charlton K. 'Breaking barriers, breaking bread': Pilot study to evaluate acceptability of a school breakfast program utilising donated food. Nutr Diet. Nov 2018;75(5):500-508. doi:10.1111/1747-0080.12478	Study design
Deger VB, Arslan N, Dag I, CifCi S. Relationship between school performance and breakfast quality in refugee children: Case study of Mardin Region. Iran J Pediatr. Jun 2021;31(3)doi:10.5812/ijp.109584	Study design
Deniz S, Oguzoncul AF. The prevalence of obesity and related factors among primary and secondary school students. Niger J Clin Pract. Dec 2019;22(12):1685-1692. doi:10.4103/njcp.njcp_173_19	Setting
Douglas SM, Byers AW, Leidy HJ. Habitual breakfast patterns do not influence appetite and satiety responses in normal vs. high-protein breakfasts in overweight adolescent girls. Nutrients. May 29 2019;11(6)doi:10.3390/nu11061223	Age

Dubuc MM, Aubertin-Leheudre M, Karelis AD. Lifestyle habits predict academic performance in high school students: The Adolescent Student Academic Performance Longitudinal Study (ASAP). Int J Env Res Pub He. Jan 2020;17(1)doi:10.3390/ijerph17010243	Intervention/exposure
Farris AR, Roy M, Serrano EL, Misyak S. Impact of breakfast in the classroom on participation and food waste. J Nutr Educ Behav. Jul - Aug 2019;51(7):893-898. doi:10.1016/j.jneb.2019.04.015	Design, Outcome
Ferrari GLD, Sole D, Pires C, Matsudo V, Katzmarzyk PT, Fisberg M. Correlates of body fat and waist circumference in children from Sao Caetano do Sul, Brazil. Cienc Saude Coletiva. Nov 2019;24(11):4019-4029. doi:10.1590/1413-812320182411.30182017	Study design
Fisberg M, Kovalskys I, Previdelli AN, et al. Breakfast consumption habit and its nutritional contribution in Latin America: Results from the ELANS Study. Nutrients. Aug 10 2020;12(8)doi:10.3390/nu12082397	Outcome
Flores YN, Contreras ZA, Ramirez-Palacios P, et al. Increased prevalence of psychosocial, behavioral, and socio-environmental risk factors among overweight and obese youths in Mexico and the United States. Int J Environ Res Public Health. Apr 30 2019;16(9)doi:10.3390/ijerph16091534	Study design
Forkert ECO, Moraes ACF, Carvalho HB, et al. Skipping breakfast is associated with adiposity markers especially when sleep time is adequate in adolescents. Sci Rep. Apr 23 2019;9(1):6380. doi:10.1038/s41598-019-42859-7	Study design
Foster GD. Error in statistical code in cluster randomized trial on the effect of a breakfast in the classroom initiative on obesity in urban, school-aged children. JAMA Pediatr. Jul 1 2019;173(7):703-704. doi:10.1001/jamapediatrics.2019.1589	Study design
Grammatikopoulou MG, Maraki MI, Giannopoulou D, Poulimeneas D, Sidossis LS, Tsigga M. Similar Mediterranean diet adherence but greater central adiposity is observed among Greek diaspora adolescents living in Istanbul, compared to Athens. Ethnic Health. 2018;23(2):221-232. doi:10.1080/13557858.2016.1258043	Outcome
Habib-Mourad C, Ghandour LA, Maliha C, Awada N, Dagher M, Hwalla N. Impact of a one-year school-based teacher-implemented nutrition and physical activity intervention: Main findings and future recommendations. BMC Public Health. Feb 19 2020;20(1):256. doi:10.1186/s12889-020-8351-3	Intervention/exposure
Hacioglu DO, Simsek H. The effect of healthy life approaches applied to families of children in preschool on obesity and healthy life behaviour. Progress in Nutrition. Mar 2019;21(1):34-45. doi:10.23751/pn.v21i1.6141	Age
Hassan BK, Cunha DB, da Veiga GV, Pereira RA, Sichieri R. Changes in breakfast frequency and composition during adolescence: The Adolescent Nutritional Assessment Longitudinal Study, a cohort from Brazil. PLoS One. 2018;13(7):e0200587. doi:10.1371/journal.pone.0200587	Outcome
Hayes JF, Giles GE, Mahoney CR, Kanarek RB. Breakfast food health and acute exercise: Effects on state body image. Eat Behav. Aug 2018;30:22-27. doi:10.1016/j.eatbeh.2018.05.006	Age, Intervention/exposure
Hearst MO, Shanafelt A, Wang Q, Leduc R, Nanney MS. Altering the school breakfast environment reduces barriers to school breakfast participation among diverse rural youth. J School Health. Jan 2018;88(1):3-8. doi:10.1111/josh.12575	Outcome
Hu J, Li Z, Li S, et al. Skipping breakfast and physical fitness among school-aged adolescents. Clinics. 2020;75:e1599. doi:10.6061/clinics/2020/e1599	Outcome
Huey TC, Siew CY, Ying LP, Bin Masrom SA, Shariff ZBM. Impact of a school nutrition program (SNP) in Malaysia. Ann Nutr Metab. 2019;75(3):366-367.	Outcome

Ichumar SO, Dahlberg EE, Paynter EB, et al. Looking through the keyhole: Exploring realities and possibilities for school breakfast programs in rural Western Australia. Nutrients. Mar 2018;10(3)doi:10.3390/nu10030371	Study design
Ikeda N, Nishi N. First incidence and associated factors of overweight and obesity from preschool to primary school: Longitudinal analysis of a national cohort in Japan. Int J Obes. Apr 2019;43(4):751-760. doi:10.1038/s41366-018-0307-7	Study design
Jankowska A, Brzezinski M, Romanowicz-Soltyszewska A, Szlagatys Sidorkiewicz A. Metabolic syndrome in obese children-clinical prevalence and risk factors. Int J Environ Res Public Health. Jan 25 2021;18(3)doi:10.3390/ijerph18031060	Study design
Jeans MR, Asigbee FM, Landry MJ, et al. Breakfast consumption in low-income Hispanic elementary school-aged children: Associations with anthropometric, metabolic, and dietary parameters. Nutrients. Jul 9 2020;12(7)doi:10.3390/nu12072038	Study design
Jose K, MacDonald F, Vandenberg M, et al. School breakfast club programs in Australian primary schools, not just addressing food insecurity: A qualitative study. Health Educ Behav. Aug 2020;47(4):619-630. doi:10.1177/1090198120920193	Setting
Jose K, Vandenberg M, Williams J, Abbott-Chapman J, Venn A, Smith KJ. The changing role of Australian primary schools in providing breakfast to students: A qualitative study. Health Promot J Austr. Jan 2020;31(1):58-67. doi:10.1002/hpja.259	Study design
Justamente I, Raudeniece J, Ozolina-Moll L, Guadalupe-Grau A, Reihmane D. Comparative analysis of the effects of daily eating habits and physical activity on anthropometric parameters in elementary school children in Latvia: Pach Study. Nutrients. Dec 14 2020;12(12)doi:10.3390/nu12123818	Study design
Kavezade S, Mozaffari-Khosravi H, Aflatoonian M, Asemi M, Mehrabani S, Salehi-Abargouei A. The effects of whole milk compared to skim milk and apple juice consumption in breakfast on appetite and energy intake in obese children: A three-way randomized crossover clinical trial. BMC Nutr. 2018;4:44. doi:10.1186/s40795-018-0253-8	Comparator
Kral TVE, Moore RH, Chittams J, et al. Caloric compensation and appetite control in children of different weight status and predisposition to obesity. Appetite. Aug 1 2020;151:104701. doi:10.1016/j.appet.2020.104701	Comparator
Larson N, Laska MN, Neumark-Sztainer D. Food insecurity, diet quality, home food availability, and health risk behaviors among emerging adults: Findings from the EAT 2010-2018 Study. Am J Public Health. Sep 2020;110(9):1422-1428. doi:10.2105/AJPH.2020.305783	Outcome
Larson N, Wang Q, Grannon K, Wei S, Nanney MS, Caspi C. A low-cost, grab-and-go breakfast intervention for rural high school students: Changes in school breakfast program participation among at-risk students in Minnesota. J Nutr Educ Behav. Feb 2018;50(2):125-132. doi:10.1016/j.jneb.2017.08.001	Duplicate
Lee HJ, Kim CH, Han I, Kim SH. Emotional state according to breakfast consumption in 62276 South Korean adolescents. Iran J Pediatr. Dec 2019;29(6)doi:10.5812/ijp.92193	Study design
Lee I, Bang KS, Moon H, Kim J. Risk factors for obesity among children aged 24 to 80 months in Korea: A decision tree analysis. J Pediatr Nurs. May - Jun 2019;46:e15-e23. doi:10.1016/j.pedn.2019.02.004	Study design
Lee JJ, Brett NR, Chang JT, de Zepetnek JOT, Bellissimo N. Effects of white potatoes consumed with eggs on satiety, food intake, and glycemic response in children and adolescents. J Am Coll Nutr. Feb 2020;39(2):147-154. doi:10.1080/07315724.2019.1620659	Intervention/exposure

Lee JJ, Brett NR, Wong VCH, Totosy de Zepetnek JO, Fiocco AJ, Bellissimo N. Effect of potatoes and other carbohydrate-containing foods on cognitive performance, glycemic response, and satiety in children. Appl Physiol Nutr Metab. Sep 2019;44(9):1012-1019. doi:10.1139/apnm-2018-0792	Intervention/exposure
Lee JY, Ban D, Kim H, et al. Sociodemographic and clinical factors associated with breakfast skipping among high school students. Nutr Diet. Sep 2021;78(4):442-448. doi:10.1111/1747-0080.12642	Study design
Long MW, Marple K, Andreyeva T. Universal free meals associated with lower meal costs while maintaining nutritional quality. Nutrients. Feb 19 2021;13(2)doi:10.3390/nu13020670	Outcome
Martinez Arroyo A, Corvalan Aguilar C, Palma Molina X, Ceballos Sanchez X, Fisberg RM. Dietary patterns of adolescents from the Chilean Growth and Obesity Cohort Study indicate poor dietary quality. Nutrients. Jul 14 2020;12(7)doi:10.3390/nu12072083	Design, Intervention/exposure
Masoomi H, Taheri M, Irandoust K, H'Mida C, Chtourou H. The relationship of breakfast and snack foods with cognitive and academic performance and physical activity levels of adolescent students. Biol Rhythm Res. Apr 2 2020;51(3):481-488. doi:10.1080/09291016.2019.1566994	Study design
McKeon GP, Shukaitis J, Cuite CL. Teachers' perceptions and attitudes toward breakfast in the classroom: The importance of health. J Sch Health. Sep 2021;91(9):741-749. doi:10.1111/josh.13064	Design, Comparator
Merlo CL, Jones SE, Michael SL, et al. Dietary and physical activity behaviors among high school students - Youth Risk Behavior Survey, United States, 2019. MMWR Suppl. Aug 21 2020;69(1):64-76. doi:10.15585/mmwr.su6901a8	Intervention/exposure, Outcome
Metro D, Papa M, Manasseri L, et al. Mediterranean diet in a Sicilian student population. Second part: breakfast and its nutritional profile. Nat Prod Res. Aug 2020;34(16):2255-2261. doi:10.1080/14786419.2018.1452016	Study design
Nicklas TA. Summary on importance of breakfast for children's health and development. Nestle Nutr Inst Workshop Ser. 2019;91:179. doi:10.1159/000493711	Study design
Ober P, Sobek C, Stein N, et al. And yet again: Having breakfast is positively associated with lower BMI and healthier general eating behavior in schoolchildren. Nutrients. Apr 18 2021;13(4)doi:10.3390/nu13041351	Study design
Onnerfalt J, Erlanson-Albertsson C, Montelius C, Thorngren-Jerneck K. Obese children aged 4-6 displayed decreased fasting and postprandial ghrelin levels in response to a test meal. Acta Paediatr. Mar 2018;107(3):523-528. doi:10.1111/apa.14165	Design, Comparator
Pablos A, Nebot V, Vano-Vicent V, Ceca D, Elvira L. Effectiveness of a school-based program focusing on diet and health habits taught through physical exercise. Controlled Clinical Trial; Journal Article; Multicenter Study. Appl Physiol Nutr Me. Apr 2018;43(4):331-337. doi:10.1139/apnm-2017-0348	Design, Intervention/exposure
Palla L, Almoosawi S. Diurnal patterns of energy intake derived via principal component analysis and their relationship with adiposity measures in adolescents: Results from the National Diet and Nutrition Survey RP (2008(-)2012). Nutrients. Feb 17 2019;11(2)doi:10.3390/nu11020422	Intervention/exposure
Pasman WJ, Hendriks HFJ, Minekus MM, et al. Subjective feelings of appetite of wholegrain breakfasts evaluated under controlled, laboratory and 'at home' conditions. Physiol Behav. Oct 1 2018;194:285-291. doi:10.1016/j.physbeh.2018.06.024	Age
Peña-Jorquera H, Campos-Núñez V, Sadarangani KP, et al. Breakfast: A crucial meal for adolescents' cognitive performance according to their nutritional status. The Cogni-Action Project. Nutrients. 2021;13(4):1320. doi:10.3390/nu13041320	Duplicate article

Rito AI, Dinis A, Rascoa C, et al. Improving breakfast patterns of portuguese children-an evaluation of ready-to-eat cereals according to the European nutrient profile model. Eur J Clin Nutr. Mar 2019;73(3):465-473. doi:10.1038/s41430-018-0235-6	Outcome
Sevil J, Garcia-Gonzalez L, Abos A, Generelo E, Aibar A. Can high schools be an effective setting to promote healthy lifestyles? Effects of a multiple behavior change intervention in adolescents. J Adolesc Health. Apr 2019;64(4):478-486. doi:10.1016/j.jadohealth.2018.09.027	Intervention/exposure
Shirazi MG, Kazemi A, Kelishadi R, Mostafavi F. The improvement of dietary behaviors among Iranian adolescent girls: a theory-based randomized controlled trial. Health Education Research. Apr 2019;34(2):159-172. doi:10.1093/her/cyz004	Intervention/exposure
Sila S, Ilic A, Misigoj-Durakovic M, Soric M, Radman I, Satalic Z. Obesity in adolescents who skip breakfast is not associated with physical activity. Nutrients. Oct 18 2019;11(10)doi:10.3390/nu11102511	Study design
Smith AP, Richards G. Energy drinks, caffeine, junk food, breakfast, depression and academic attainment of secondary school students. J Psychopharmacol. Aug 2018;32(8):893-899. doi:10.1177/0269881118783314	Intervention/exposure
Stennett M, Blokland A, Watt RG, Heilmann A. Mid-adolescent ethnic variations in overweight prevalence in the UK Millennium Cohort Study. Eur J Public Health. Apr 24 2021;31(2):396-402. doi:10.1093/eurpub/ckab023	Study design
Stokes N, Spruance L, Patten EV, Lybbert EK. Teachers' experience and perspectives of traditional breakfast and breakfast in the classroom. J Nutr Educ Behav. Sep 2019;51(8):936-945. doi:10.1016/j.jneb.2019.04.004	Duplicate article
Tan ML, Laraia B, Madsen KA, Johnson RC, Ritchie L. Community eligibility provision and school meal participation among student subgroups. J Sch Health. Oct 2020;90(10):802-811. doi:10.1111/josh.12942	Study design
Teng CY, Chin YS, Taib MNM, Chan YM. Evaluation of the effectiveness of a 3-year, teacher-led healthy lifestyle program on eating behaviors among adolescents living in day school hostels in Malaysia. Food Nutr Bull. Dec 2018;39(4):595-607. doi:10.1177/0379572118795358	Outcome
Teo CH, Chin YS, Lim PY, Masrom SAH, Shariff ZM. Impacts of a school-based intervention that incorporates nutrition education and a supportive healthy school canteen environment among primary school children in Malaysia. Nutrients. May 18 2021;13(5)doi:10.3390/nu13051712	Intervention/exposure
Terry AL, Wambogo E, Ansai N, Ahluwalia N. Breakfast intake among children and adolescents: United States, 2015-2018. NCHS Data Brief. Oct 2020;(386):1-8.	Publication status
Tilles-Tirkkonen T, Nuutinen O, Sinikallio S, Poutanen K, Karhunen L. Theory-informed nutrition education curriculum Tools For Feeling Good promotes healthy eating patterns among fifth grade pupils: Cross-sectional study. J Hum Nutr Diet. Oct 2018;31(5):647-657. doi:10.1111/jhn.12568	Intervention/exposure
Troiano G, Simi R, Mercurio I, et al. "OKKIO alla salute 2014" results from the Tuscan sample. Ann Ig. Jul-Aug 2018;30(4):259-272. doi:10.7416/ai.2018.2218	Study design
Turner L, Guthrie JF, Ralston K. Community eligibility and other provisions for universal free meals at school: Impact on student breakfast and lunch participation in California public schools. Transl Behav Med. Oct 1 2019;9(5):931-941. doi:10.1093/tbm/ibz090	Intervention/exposure
Vaidehi U, Shashikala S, Mirnalini K. Association between food habits and nutritional status of secondary school students in Kuala Lumpur, Malaysia: Baseline findings from Nuteen project. J Nutr Sci Vitaminol. 2020;66:S256-S261. doi:10.3177/jnsv.66.S256	Study design

Valizadeh P, Ng SW. The New school food standards and nutrition of school children: Direct and indirect effect analysis. Econ Hum Biol. Dec 2020;39:100918. doi:10.1016/j.ehb.2020.100918	Intervention/exposure, Outcome
Vaudrin N, Lloyd K, Yedidia MJ, Todd M, Ohri-Vachaspati P. Impact of the 2010 US Healthy, Hunger-Free Kids Act on School Breakfast and Lunch Participation Rates Between 2008 and 2015. Am J Public Health. Jan 2018;108(1):84-86. doi:10.2105/Ajph.2017.304102	Study design
Vik FN, Naess IK, Heslien KEP, Overby NC. Possible effects of a free, healthy school meal on overall meal frequency among 10-12-year-olds in Norway: The School Meal Project. BMC Res Notes. Jul 5 2019;12(1):382. doi:10.1186/s13104-019-4418-6	Outcome
Vilela S, Correia D, Severo M, et al. Eating frequency and weight status in Portuguese children aged 3-9 years: Results from the cross-sectional National Food, Nutrition and Physical Activity Survey 2015-2016. Public Health Nutr. Oct 2019;22(15):2793-2802. doi:10.1017/S1368980019000661	Study design
Vilela S, Oliveira A, Severo M, Lopes C. Chrono-nutrition: The relationship between time-of-day energy and macronutrient intake and children's body weight status. J Biol Rhythms. Jun 2019;34(3):332-342. doi:10.1177/0748730419838908	Age
Wadolowska L, Hamulka J, Kowalkowska J, et al. Changes in sedentary and active lifestyle, diet quality and body composition nine months after an education program in polish students aged 11-12 years: Report from the ABC of Healthy Eating Study. Nutrients. Feb 2019;11(2)doi:10.3390/nu11020331	Design, Intervention/exposure
Weng CB, Sheu JJ, Chen HS. Factors associated with unhealthy weight control behaviors among a representative sample of U.S. high school students. J Sch Nurs. Oct 19 2020;doi:10.1177/1059840520965497	Outcome
Whisner CM, Angadi SS, Weltman NY, et al. Effects of low-fat and high-fat meals, with and without dietary fiber, on postprandial endothelial function, triglyceridemia, and glycemia in adolescents. Nutrients. Nov 2 2019;11(11)doi:10.3390/nu11112626	Comparator
Wu CH, Lin CY, Hsieh YP, et al. Dietary behaviors mediate the association between food insecurity and obesity among socioeconomically disadvantaged youth. Appetite. Jan 1 2019;132:275-281. doi:10.1016/j.appet.2018.10.013	Study design
Xu H, Ecker O, Zhang Q, et al. The effect of comprehensive intervention for childhood obesity on dietary diversity among younger children: Evidence from a school-based randomized controlled trial in China. PLoS One. 2020;15(7):e0235951. doi:10.1371/journal.pone.0235951	Intervention/exposure
Yaguchi-Tanaka Y, Tabuchi T. Skipping breakfast and subsequent overweight/obesity in children: A nationwide prospective study of 2.5- to 13-year-old children in Japan. J Epidemiol. Jul 5 2021;31(7):417-425. doi:10.2188/jea.JE20200266	Age
Yao J, Liu Y, Zhou S. Effect of eating breakfast on cognitive development of elementary and middle school students: An empirical study using large-scale provincial survey data. Med Sci Monit. Nov 22 2019;25:8843-8853. doi:10.12659/MSM.920459	Study design
Yasuda J, Gomi T, Kotemori A, et al. Breakfast before resistance exercise lessens urinary markers of muscle protein breakdown in young men: A crossover trial. Nutrition. Mar 2021;83doi:10.1016/j.nut.2020.111088	Age, Intervention/exposure
Yilmazbas P, Gokcay G. Assesment of obesogenic factors in school-age children. Turk J Pediatr. 2021;63(2):185-192. doi:10.24953/turkjped.2021.02.001	Study design
You Y, Zhang F, Han J, et al. Breakfast preferences and consumption location among children at a median age of 7 in Shenzhen: Implications for managing overweight and obesity. Appetite. Jan 1 2021;156:104851. doi:10.1016/j.appet.2020.104851	Intervention/exposure

Zakrzewski-Fruer JK, Wells EK, Crawford NSG, Afeef SMO, Tolfrey K. Physical activity duration but not energy expenditure differs between daily and intermittent breakfast consumption in adolescent girls: A randomized crossover trial. J Nutr. 2018;148(2):236-244. doi:10.1093/jn/nxx055	Outcome
Zeinstra GG, Vingerhoeds MH, Vrijhof M, van Mourik S, Houtzager RN, van Kleef E. Changing the behaviour of children living in Dutch disadvantaged neighbourhoods to improve breakfast quality: Comparing the efficacy of three school-based strategies. Appetite. Jun 1 2019;137:163-173. doi:10.1016/j.appet.2019.02.011	Outcome